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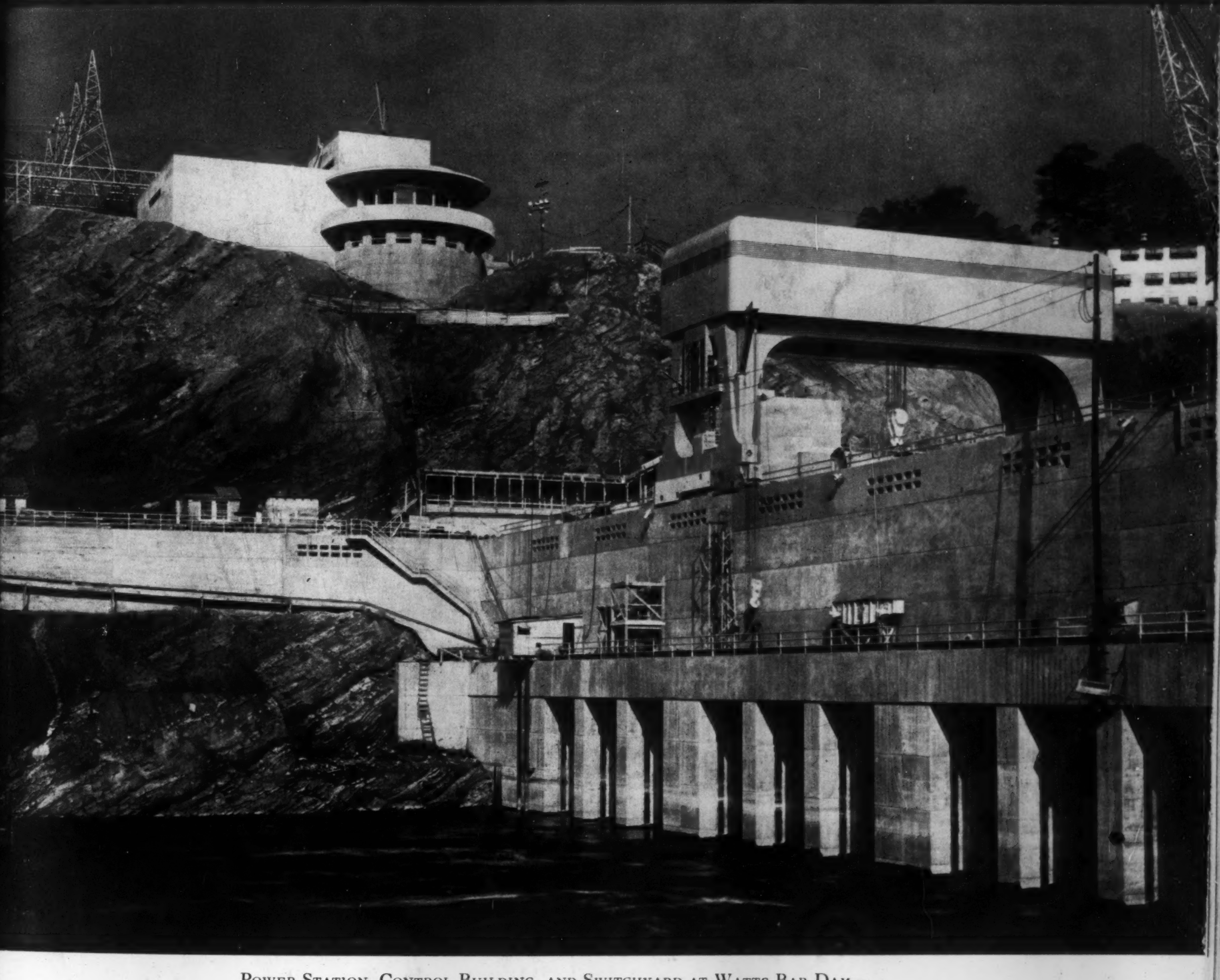

Power Station, Control Building, and Switchyard at Watts Bar Dam—
A Unit in the TVA System (*See article, page 144*)

Volume 13 Number 3

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

MARCH 1943

O'er the land of the free . . .

And the home of the brave. A nation of men and women who are willing to make every sacrifice to preserve their precious ideals — who will give their lives, if necessary, to keep democracy's light shining from these shores. Every true American — whether his job lies on the battle front, the production front or the home front — must awaken to the crisis that faces this nation today. He must not allow himself to be blinded by selfish ambition, personal comfort or by false illusions of security. He must open his eyes to the mortal peril in which his nation stands, and act accordingly. Oh say can you see?

* * *

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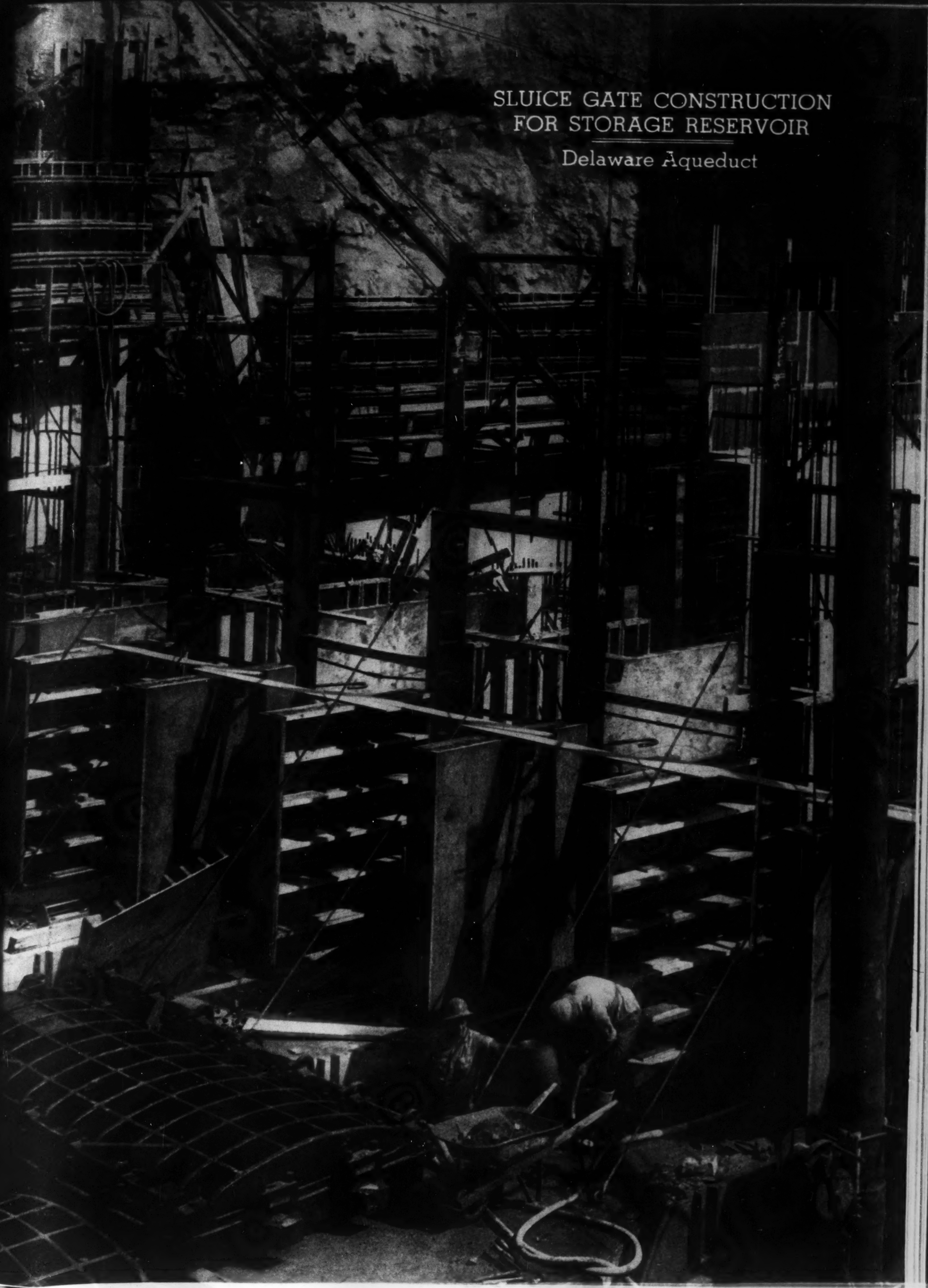

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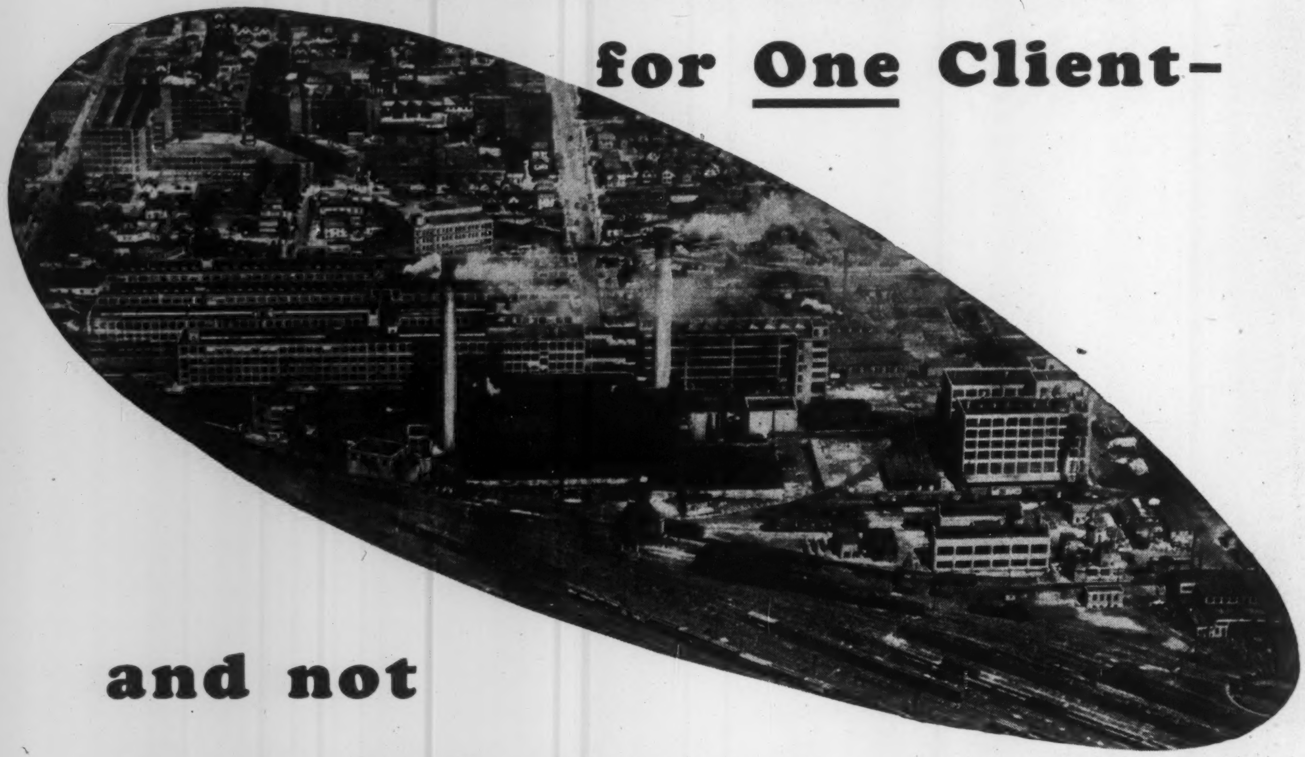

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Ethical Standards—How Best Developed?

Paper Presented Before University of Wisconsin Student Chapter, Which Won 1942 Mead Prize

By Alfred C. Ingersoll, Jun. Am. Soc. C.E.
Formerly Member of Student Chapter, University of Wisconsin, Madison, Wis.

ETHICAL standards, it appears to me, are those codes and rules which govern the conduct of an individual in his social and professional relations. "Good" ethical standards are founded on the principles of honesty, integrity, high morals, and good citizenship. Most of these elements are found in the written law.

Beyond Merely Lawful.~But this term connotes a great deal more than "law-abiding standards." Thus a man can meet every requirement of the law regarding morals and still have a low moral standard in his business relationships. Furthermore, he can obey every letter of the law pertaining to citizenship and yet be a poor citizen. In short, then, ethical standards may be defined as those principles of conduct by which men live, principles which are not contained in, and cannot be enforced by, the law of the land.

Standards of ethics may be roughly divided into two classes, those imposed on a man by the organization or the society in which he works, and those which he imposes upon himself. It is presumed here that any man who is to be successful in a profession must follow, as a bare minimum, the standards of ethics laid down by the leaders of social and humanitarian thinking in that profession. That is, we are considering only those codes of ethics which a man must establish for himself and himself alone, and which are enforceable solely by his will-power and good judgment.

It would be pretentious indeed for me to think that this paper might correct the ways of a person who has habitually used substandard codes of ethics. Such codes, be they good or bad, have doubtless become ingrained in his personality and thought processes. So they are not easily, if ever, changed. This paper has a far more practical and feasible purpose, namely, to promote, through education, the adoption of a sound and just code of ethics while the mind of the individual is in a pliable state and can be molded without great difficulty.

Stages in Moral Sensitivity.~It has been stated that there are four periods of mental development through which a person passes in the course of his lifetime. In infancy and early childhood he takes everything, gives nothing, and hardly concerns himself about anything. Then, in adolescence he begins to open his eyes to the world, a world which revolves about him as an axis. He thinks widely and begins to formulate many of his life ideals and habits, even though he is immature at the time.

In the third period of early adulthood he is governed by his energy and ambition. He is anxious to work hard and make a name for himself in his profession. He is conscientious and painstaking; but he is an egoist and his thoughts of and for others lie only in those channels which directly affect himself. For the greater part, young men remain in this stage until well into their thirties. It is unfortunately true that there are a great number who never leave this stage, who are doomed always to think and act within the narrow confines of self-devotion. Finally, in middle and later adulthood, he sees himself in true perspective as an integral part of the society in which he lives. He recognizes his obligations to that society and commences to assume them. He becomes philanthropic within his ability and he begins to appreciate the Golden Rule.

Education Affects His Understanding.~But what has all this to do with ethical standards? Not until the fourth stage does a man truly appreciate the meaning of a standard of ethics. All standards, however, whether of ethics or of something else, are started and developed in the second and third stages. Without education or information a young man is left to formulate his own ethical standards. They may, or may not, be good. These standards are largely influenced by the people with whom he associates, professionally and otherwise. If he is fortunate and has made the right contacts, his standards are undoubtedly good.

But how about the young man starting out who does not come in close contact with those exemplifying the higher ideals of his profession, the man who comes up "the hard way?" He probably tries out the standards of those close to him. If they work it is likely that he will take them for his own without a great deal of further thought. And if they are not good, he suffers for it later.

The point is that he may formulate sound standards, no matter what his associations, if he has been educated to them earlier in his life. It is my thesis that the education of students in schools and universities in good ethical standards is a desirable thing; that it is the obligation of every right-thinking professional man to see that such education is practiced as fully as possible.

From the Student's Viewpoint.—It is difficult indeed for a student to place himself in the position of a man who has been in practice for a number of years, to speak of the ethical problems which that man must meet. It is far more logical for the student to speak of the problems which confront him and have become a part of his personal experience. That is, in truth, the only manner in which I, for example, could pretend to speak with understanding.

Most of us who are students in civil engineering courses have been schooled in the bare fundamentals of professional ethics. We have been taught, for instance, not to accept favors knowingly while acting in an advisory position, and to look carefully for one-hundred dollar bills wrapped around cigars given to us by contractors.

These are important things to know, of course, but the whole set-up seems a far cry from the classroom. To me at least, it seems that a great deal of territory close by has been overlooked in favor of detailed discussions of problems which may confront us students fifteen years from now. It is easier to develop a standard of ethics in relation to the problems we meet every day than for those problems which we can conjure up only in the mind's eye. Some of the ethical problems which bear directly on the student while he is a student are presented in the following paragraphs.

Honor in the Classroom.—Take the matter of honesty in examinations. This has been discussed by all concerned many times. There are few students, at least in the engineering courses, who do not respect an examination and appreciate its true purpose. It is usually the case that those few students who are inclined to cheat on examinations are just the ones who are weeded out in the first year or two anyway. So they do not seriously affect the moral standard of the class as a whole.

There is, however, a more serious and insidious situation of a like nature, in the matter of technical problems and reports. It is common knowledge that, the night before a certain class problem is due, a group of students will get together and compare answers and methods; or they may even work the problem together. This is not essentially bad ethics. It is even regarded as good practice by a number of the faculty, provided that the students do individual work on the problem before checking answers.

What, then, is the student to do when an instructor demands absolutely individual work? The chances are that he does just as he has done before, because, he reasons, if one instructor allows it there can be no ethical objection to it. Otherwise, why should not the instructors get together on their standards? His conscience is clear.

Ghost-Written Reports.—Closely allied to this question of the technical problem is that of the engineering report. In this case there is no question in anyone's mind. The report is supposed to be written by the individual without help. The student knows that he can, if he wishes, obtain previously prepared and graded reports, either from his upper-class friends or from some "underground" dormitory and fraternity files. He also knows, and this is the important fact, that many of the top men in his school, respected and liked by both faculty and students, have employed this method of semi-plagiarism and have found it profitable indeed. This case is very different from the cheating in examination where the cheater is generally disrespected and scorned by his fellow students and thrown out of school by the faculty.

If the man is an average student, he reasons thus: "Why take a chance on this report? I need the grade. The requirements are awfully indefinite anyway. If it has worked for those fellows it will work for me. They're sitting pretty enough." It is not difficult to take another person's report and change it to your own wording and style. The rest is easy and it probably works very well. Again the student's conscience is clear. The same day he learns not to accept gratuities from contractors, he more or less copies a report on mechanics. It should not be so. While studying standards of ethics for the professional man, he should be establishing his own standards to apply to the things close to him.

Connivance on the Job.—Practically every student has a summer job of some sort before he leaves school. This first contact with the cold business world is likely to find him wondering about many things. He often runs into a situation where his immediate superior tells him to do a certain thing and "forget it," or "don't mention it to the big boss." He may know for a fact that this particular thing is a breach of the specifications and that the "big boss" should know about it. He also knows that he is young, new on the job, and he doesn't want to get himself into trouble.

The chances are that he takes the situation to an older friend who has worked there longer. The advice is invariably, "Keep your mouth shut, sonny, and you'll get along just fine." And that is what he does. He starts to build his standards of ethics on such experiences and advices rather than on the organized rules of conduct established by the leaders of his profession. A little more careful thought and teaching, both in and out of school, might make a considerable difference in these self-styled standards.

On Denying Himself.—In his senior year, the student is apt to apply for several different jobs which interest him. He does not wish to commit himself to any one of them sooner than he has to, but ordinarily he is under a bit of pressure to do so. After he has accepted a job, it is a question of ethics whether he takes that job or another more desirable position which has opened since his acceptance. If he has developed high ethical standards, he will stick to his word, for he is entering, by whichever door may be open, a profession of honor and integrity. If he has not developed high standards, he may weaken and will undoubtedly suffer for it in lack of prestige and respect at a later time.

Once I asked a fellow student what he thought of ethical standards. "They would be all right," was the reply, "if everybody followed them, but since they don't, what's the use?" His father was a contractor and he had probably taken his ethical theories from some of his father's unfortunate business experiences. If this student and all others like him had been properly educated in high ethical standards, they would be a greater credit to their profession as well as better citizens of their country.

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CIVIL ENGINEERING
March 1943

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The New War Department Building Road Network

World's Largest Office Building Makes Necessary a New System of Express Highways

By Joseph Barnett, M. Am. Soc. C.E.
Principal Highway Design Engineer, Public Roads Administration, Federal Works Agency, Washington, D.C.

Location of the War Department's huge new Pentagon Building on the Virginia side of the Potomac River created for the thousands of daily workers and numerous visitors the problem of traveling to and from these new offices, and for through traffic, the problem of passing through the area. Design and layout by the Public Roads Administration, in cooperation with the War Department, provided for rapid movement of large volumes of traffic. The plan, as explained by Mr. Barnett, avoids as many loop turns as possible on selected through routes on the network.

The world's largest office building, to house 40,000 War Department employees, has just been completed in Arlington County, Va., just across the Potomac River from the nation's capital. The traffic thus created, superimposed upon that which was already overburdening the road system, made necessary a new network of highways. Thus facilities had to be provided for vehicular traffic between the river bridges, the new building, and the through highways in Virginia.

In 1941 the three major bridges over the Potomac River had an average weekday traffic of 118,000 motor vehicles, and a peak hourly load of about 11,000. The bridges had a capacity greater than these volumes but because of inadequate approaches they were frequently jammed with traffic. To solve the problem it was necessary to develop in the record-breaking time allowed for the construction of the building, a system of adequate bridge approaches and express types of collecting and distributing highways on both sides of the river that would enable all traffic to flow without interruption. Such a system of highways would increase the capacity of the river bridges by at least 40% and bring it above the expected traffic load.

The Pentagon Building, as the new building is called because of its five-sided plan, and other nearby temporary federal office buildings, are to accommodate 54,000 wartime workers. Moving these workers from offices in the District of Columbia to the Virginia side of the Potomac River had an appreciable effect on the traffic pattern. Surveys indicated that 7 out of 8 of these workers lived north of the river, so that whereas 1 out of 8 of them formerly crossed the river in the same direction as the peak flow, after the change 7 out of 8 would cross against the direction of peak flow. When the Pentagon Building is fully occupied, the direction of peak flow may be reversed, or at least the flow in both directions may be equalized.

The traffic load was calculated separately for wartime and peacetime operation because of the probable increase in through traffic and decrease in commuting traffic after the war is over. The intensive housing developments beyond the federal building area in Virginia are expected to relieve some of the load on the river bridges. Direct connections to the housing areas were provided in the design. The large effect of the federal workers has its favorable aspect in that the traffic load can be adjusted by staggering the working hours as found necessary. Not all cities are blessed with a traffic valve ajustable at will, although the desired effect can be produced elsewhere by cooperation between large businesses, public and quasi-public organizations, and schools.

As shown in Fig. 1, the network resolved itself into a triangle of major routes around the Pentagon Building. Existing important through routes are shown by heavy dashed lines. The extensive system of roads connecting through roads to the loading platforms inside the building, to the parking areas, and to the various building entrances are shown by light dashed lines. The network as constructed consists of 17 miles of one-way through roads, 7.7 miles of one-way ramps, and 21 grade-separation structures, one of which provides for the separation of three intersecting roads. It also includes 2.3 miles of local service roads. These lengths do not include the

Additional Areas Are Provided for Hesitant Drivers
Granite-Block Strip at Left Defines Edge of Through Lane; Double Curb with Reflectors Faces Oncoming Drivers

roads connecting through routes to the Pentagon Building and parking areas.

Origins and destinations of traffic on the network are diverse, and the design provides a system which as a whole will be as flexible as possible. A driver will have considerable latitude in the choice of route to a general destination, and it will be easy for him both to make the choice and to follow it. The system is also flexible enough to enable military vehicles to use one route and civilian vehicles another, or to permit alternate routes to be used where a major route is temporarily closed—an important consideration in these critical times. Flexibility is provided in still another sense. Wrong design assumptions or changes in the traffic pattern may later make it necessary to provide additional capacity here and there in the form of widened pavements, added relief roads, or other measures. In the design of the network, the door was not closed to future improvements.

The loops of the conventional clover-leaf grade separation are both indirect and limited in capacity, even when liberally designed. If provision is to be made for the free flow of large volumes of traffic, the path should head in the general direction of the destination and not require a right-turn 270° loop for a left turning movement. Provision of direct paths, rather than loops, is economical where heavy volumes are involved. Ramps for high-standard roads are rather expensive and the additional travel time and distance required on extensive loops result in additional operation costs. Considerable capital expenditures for their elimination are therefore justified. An example of providing a direct path instead of the conventional clover-leaf loop is found in Bridge 18 (Fig. 1), which provides for traffic southbound to existing U.S. Route 1 in lieu of a loop in the northwest quadrant at Bridge 10.

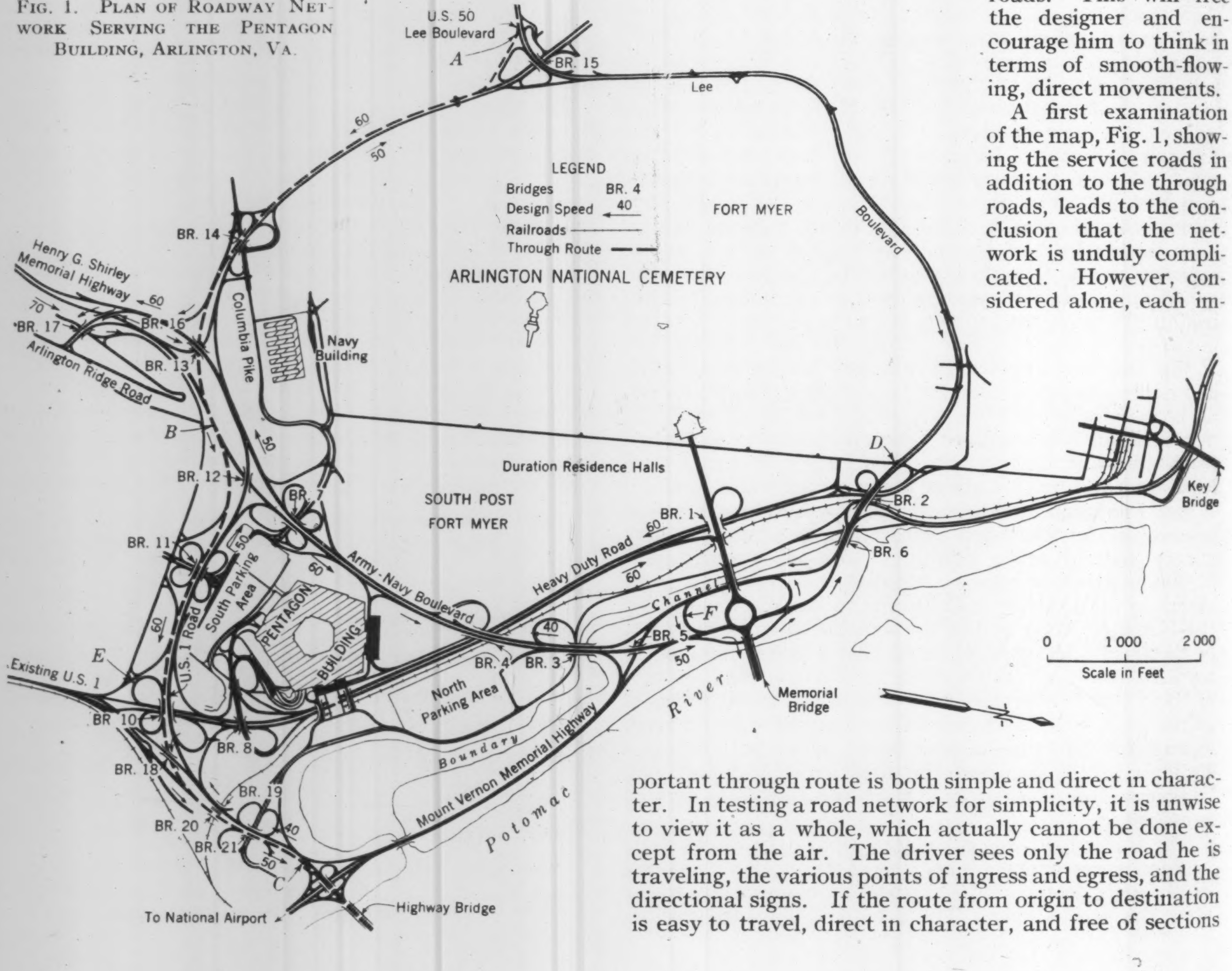
TRAFFIC MIXING ROADS PROVIDED

The requirements of flexibility and directness for through movements resulted in the over-all design being based on two mixing roads, one for each direction of traffic, located just east of the 3-level bridge, No. 13. Each of these mixing roads is 48 ft wide and about 900 ft long. The two heaviest traffic streams, those on U.S. Route 1 and on the Army-Navy Boulevard, merge into and emerge from these mixing roads in a natural manner. Traffic headed right veers to the right and traffic headed left veers to the left.

Direct interchange for the through traffic streams leads to spreading the one-way roads near a grade separation structure to the extent that the designer finds he is not dealing with the center line of a divided highway but instead is using separate alinements and profiles for one-way roads. Experience in the design of this and other networks of express types of highways leads strongly to the conclusion that the entire concept of "divided highways" or "double-barreled highways" or "highways with parkway medians" or whatever they may be called, should be discarded in metropolitan areas in favor of a system of one-way roads. This will free the designer and encourage him to think in terms of smooth-flowing, direct movements.

A first examination of the map, Fig. 1, showing the service roads in addition to the through roads, leads to the conclusion that the network is unduly complicated. However, considered alone, each important through route is both simple and direct in character. In testing a road network for simplicity, it is unwise to view it as a whole, which actually cannot be done except from the air. The driver sees only the road he is traveling, the various points of ingress and egress, and the directional signs. If the route from origin to destination is easy to travel, direct in character, and free of sections

FIG. 1. PLAN OF ROADWAY NETWORK SERVING THE PENTAGON BUILDING, ARLINGTON, VA.


U.S. 50
Lee Boulevard
A
BR. 15
Lee
60
50
LEGEND
Bridges BR. 4
Design Speed 40
Railroads
Through Route
FORT MYER
Boulevard
BR. 14
Henry G. Shirley Memorial Highway
60
70
BR. 17
BR. 16
BR. 13
Arlington Ridge Road
Columbia Pike
Navy Building
ARLINGTON NATIONAL CEMETERY
B
50
BR. 12
BR. 7
Duration Residence Halls
D
BR. 2
Key Bridge
SOUTH POST
FORT MYER
BR. 1
BR. 11
South Parking Area
50
60
Army-Navy Boulevard
Heavy Duty Road
60
60
BR. 6
Channel
F
PENTAGON
BUILDING
40
BR. 5
0
1 000
2 000
Scale in Feet
E
Existing U.S. 1
U.S. 1 Road
60
BR. 4
BR. 3
North Parking Area
50
River
Memorial Bridge
BR 10
BR. 8
Boundary
Mount Vernon Memorial Highway
BR. 18
BR. 19
BR. 20
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BR. 21
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Potomac
C
To National Airport
Highway Bridge

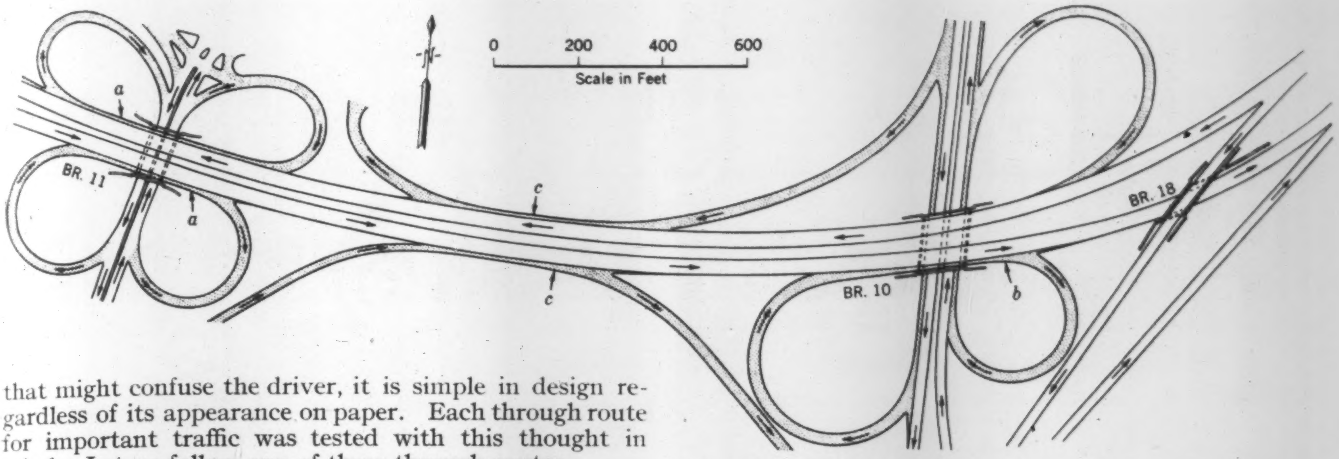


Fig. 2. A Section of U.S. Route 1, with Location of Speed-Change Lanes

that might confuse the driver, it is simple in design regardless of its appearance on paper. Each through route for important traffic was tested with this thought in mind. Let us follow one of these through routes.

The route indicated on Fig. 1 by a heavy line shows the path of a vehicle on U.S. 50 (upper right) headed toward downtown Washington via Highway Bridge (lower left). The driver enters the network at point *A* by turning right, and his first and only major choice is at point *B* on the inbound mixing road, where he must decide to keep to the right to go toward Highway Bridge. This decision is natural and would normally be made in the complete absence of directional signs. This figure also is one illustration of the flexibility of the system as regards choice of route. The driver can reach Highway Bridge even if he does not turn right at point *A* by continuing on Lee Boulevard and the Memorial Highway and then using the loop at the cloverleaf at point *C*. Or he can change to the Heavy Duty Road at point *D* and use the loop at point *E*. If he is headed for Memorial Bridge, either he can follow the first described path and choose the natural route to the left at point *B* or, if he turns left at the point of entry, he can continue on Lee Boulevard past point *D* and is directed to Memorial Bridge at point *F*, where a liberal turn is provided.

MAJOR CONSIDERATIONS OF DESIGN

The geometric design standards were based upon the common denominator of assumed design speed, which was chosen not on the usual basis of curvature limitation, since all curves were flat, but by the relation of the through roads to the surroundings and approaches such as the river bridges. The design speeds are shown in Fig. 1. The design speeds of the one-way roads leading away from Washington were assumed to be lower than those for the roads leading toward the city because observations indicate that drivers find it difficult to slow down from the speed of the open road as they approach a city, and that they require time to pick up speed on leaving it.

Maximum curvature on the through roads was 4°, except for one curve on U.S. Route 1 approaching Highway Bridge, which was 4° 30′. All curves sharper than 2° were transitioned and all curves sharper than 1° were superelevated, except one or two where the architectural effect would have been undesirable. Up grades on the major truck routes were limited to 3% and down grades were kept to 4% in almost all cases.

Sight-distance requirements were based on the design speed in accordance with "A Policy on Sight Distance" by the Special Committee on Administrative Design Policies of the American Association of State Highway Officials. Minimum clearances at structures were 14 ft vertical, 3 ft horizontal to railings, and 6 ft to abutments or piers, with some exceptions in the latter. To insure adequate sight distance on curved roads, lateral clearances to the abutments of three bridges were made 12, 15, and 18 ft, respectively.

Traffic lanes were made uniformly 12 ft wide. No widening was necessary on through routes. All roads were lined with curbs which generally are 6 in. high on the right of traffic, where sidewalks are planned for the adjacent space, and 3 in. high elsewhere. Curbs were sloped back $1^1/_2$ in. and rounded at the top.

DESIGN OF RAMPS

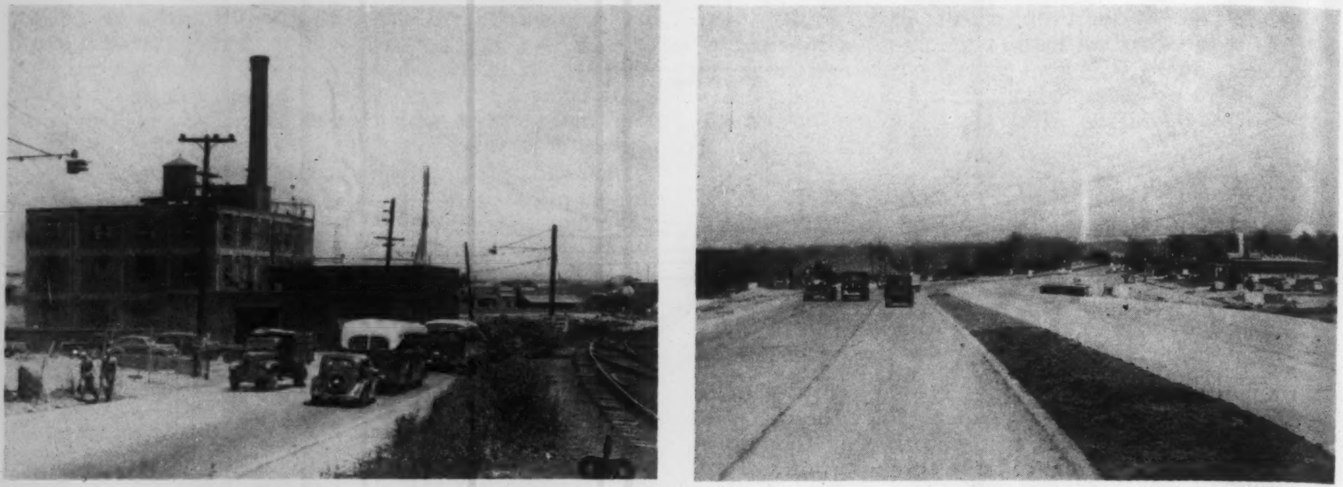
Ramps were designed for 0.7 of the design speed of the through roads except for some of the loops at cloverleaf grade separations, where it was impracticable to do so because of the lack of space and because a large loop results in considerable extra travel distance and high maintenance costs. These loops were designed for somewhat lower speeds but their termini were provided with transitions or compound curves of larger radii than elsewhere on the loops. The minimum radius on most loops was either 130 or 180 ft. Widths of ramps were made to conform to Table I, which is based on the table in "A Policy on Intersections at Grade" of the American Association of State Highway Officials.

Table I. Widths of Pavement for Ramps, in Feet

Radius (Ft)	One-Lane Operation		Two-Lane Operation	
	No Provision for Passing	Provision for Passing Stalled Vehicle	Normal Traffic	Bus Routes
50	17	28	32	34
100	14	24	27	29
150	14	22	26	28
200	14	22	26	28
300	14	21	26	28
400	14	20	26	28
500	14	20	26	28

Gradients on up-grade ramps were limited to 3 or 4% where heavy truck interchange was expected. Up-grade ramps where the predominant traffic was expected to be passenger vehicles, and down-grade ramps were on gradients of 3 to 6%.

Where the difference in design speeds of ramp and through road was appreciable, additional pavement area for speed change was provided. Generally this took the form of an added lane on the right of traffic across a structure between the point of ingress from one inner loop to the point of egress to the next inner loop. This necessitated widening the structure. At some points the outer connection at one grade separation was so close to the outer connection at an adjacent grade separation that it was deemed desirable to provide an additional lane between the adjacent points of ingress and



THE SOUTH APPROACH TO THE NATION'S CAPITAL, ON U.S. ROUTE 1, BEFORE AND AFTER RECONSTRUCTION

egress. Though the need is not so great here, the added area for speed change will provide extra space for weaving and maneuvering. The cost of the additional area in this case is not so great as when providing an additional lane between adjacent inner loops, since no increase in structure is involved.

In Fig. 2 is shown a section of U.S. Route 1 to illustrate the location of these added lanes. Points *a* and *b* at Bridges 10 and 11 indicate additional lanes between adjacent inner loops. An increase in width of structure is required in each case. Note that in the case of Bridge 10, additional width was not provided in the opposite side of the structure because there is no inner loop in the upper left quadrant, and the loop in the upper right quadrant is designed for entrance to the through road at a fairly high speed. Also note the added lanes between the outer connections at points *c*.

CONTRAST IN SURFACE TEXTURE

Pavements of most of the through traffic lanes are of concrete 9 or 10 in. thick, of uniform cross section. Welded wire fabric was used near the top surface only where it was deemed necessary because of poor foundations and the short time allowed for placing the fills and preparing the subgrades. Added lanes and ramps were paved with a plain concrete base 7 or 8 in. thick, topped with hot asphaltic concrete $1^1/_2$ or 2 in. thick. It was thought that this would give a sufficient contrast in color and surface texture between the through lanes and the others, subconsciously informing drivers when they are not on the through lanes and should slow down and be alert. Unfortunately war measures dictated that carbon black be used in the concrete pavements to reduce visibility from the air so that the contrast in color is not as great as it might have been. For the same reason white cement for high-visibility curbs was deemed undesirable. Concrete curbs are integral with the concrete pavement and base course.

It was also thought that contrast in surface texture might be obtained by using a primary course of hot asphaltic concrete, and after initial rolling, spreading a surface course of $^1/_2$-in. chips at the rate of 10 to 15 lb per sq yd, to be rolled into the primary course while it is still hot. This method did not provide a surface texture of sufficient contrast to warn drivers. In fact observations on driving over several types of bituminous surfaces indicated that the contrast between the surface textures of concrete pavements and high-type bituminous pavements is not sufficient to affect driver behavior materially except where open-surface macadam pavements are used.

The Heavy Duty Road and the Army-Navy Boulevard have two concrete traffic lanes and one continuous bituminous lane in each direction. The U.S. Route 1 has three concrete traffic lanes in each direction with added speed-change areas of bituminous surface where required. On the latter road a strip of Durax, or small granite-block paving about a foot wide, was used along the right edge of the through traffic lane between the concrete surface and the bituminous surface in the length where interchange traffic leaves the through traffic lane.

This strip was not used where traffic merges because it is desirable that entering traffic make use of every break in the traffic stream to enter the through lane. This strip appears in an accompanying photograph, which also shows the added width provided for maneuvering where a one-way road forks or separates into two one-way roads. The nose was made on a radius of 2 ft 6 in. with the curb at least 2 ft from the edge of the through traffic lane to provide added length for the driver who changes his mind or discovers that he is heading toward the wrong road.

Grade separation structures were of several types. The longest of those included in this project has four spans and continuous steel girders. Most of the structures are reinforced-concrete rigid frames of one or two spans. They are faced with cut stone because the network is part of the permanent road system of the nation's capital, in close proximity to the Arlington National Cemetery, the parks along the Potomac, and public buildings of outstanding excellence. One structure, Bridge 13, not yet completed, separates the grades of three roads crossing at one point. Paul P. Cret of Philadelphia was retained as consultant on the architectural phases of the structures. The whole area will be landscaped, and grading was designed with this in mind.

Design and construction of the highway network is a cooperative undertaking resulting from an agreement between Lt. Gen. Brehon B. Somervell, M. Am. Soc. C.E., of the U.S. Army, and Commissioner Thomas H. MacDonald of the Public Roads Administration, Federal Works Agency. In general, the main highway system and interchanges were designed by, and constructed under the supervision of, the Public Roads Administration; and the roads to the building and parking areas, the parking areas themselves, and the highway facilities inside and adjacent to the building were designed by, and constructed under the supervision of, the War Department.

The Alcan Military Highway

FOR years a highway connecting the Pacific Northwest states with Alaska has been discussed by highway authorities. The war, which has forced action on so many pending projects, made such a highway necessary as a supply line for military operations in Alaska and en route. Considerable interest was aroused by the papers presented at the Wednesday afternoon session of the Annual Meeting in New York, which was devoted to full discussion of the Alcan Highway. Two of the papers, by men in direct charge of the work, appear here; others will follow in subsequent issues.

History, Organization, and Progress

By C. L. Sturdevant, M. Am. Soc. C.E.

Brigadier General, Corps of Engineers, U. S. Army; Assistant Chief of Engineers, Washington, D.C.

On Monday, February 2, 1942, a decision to undertake the construction of a highway to Alaska was announced to the Chief of Engineers. A route connecting a series of airfields from Fort St. John, British Columbia, to Big Delta on the Richardson Highway in Alaska was to be selected. The Chief of Engineers submitted such a plan on February 4, and a formal directive to proceed with the project was received on February 14.

Permission was promptly obtained to send survey parties into Canada, and a formal agreement with the Canadian Government was reached on February 26 which, among other things, provided that the United States would pay for the construction and that rights-of-way would be furnished by the Canadians. On March 9 and 10, Quartermaster and Engineer troops began arriving at the end of the railroad at Dawson Creek, British Columbia, in sub-zero weather.

The plan submitted to the War Department, Fig. 1, was necessarily quite general in character, but it was apparent at once that the main impediment to rapid progress was the fact that there were only four practicable points of access by land to the entire 1,600-mile route; namely, at the two extremities, at Whitehorse, and at some undetermined point on Teslin River or Teslin Lake which could be reached by steamer from Whitehorse. A fifth and difficult route of access to Watson Lake by way of the Stikine and Dease rivers was considered but discarded as impracticable.

The magnitude of the project, the need for speedy construction, and the limited accessibility indicated the necessity for a two-phase construction program, the operations in the first phase to provide with utmost rapidity a rough minimum road to make possible the early and extended distribution of many additional crews which in the second phase would improve and complete the road.

Engineer troops are trained and equipped for rapid road construction. Moreover troops were available for prompt dispatch, whereas a part of the season would probably be lost if civilian forces only were to be utilized. Consequently, engineer regiments were given the mission of building the access road which has been generally referred to as the pioneer road. The specifications for the latter were very brief and were included in instructions of the Chief of Engineers to troop commanders as follows:

"A pioneer road is to be pushed to completion with all speed within the physical capacity of the troops. The objective is to complete the entire route at the earliest practicable date to a standard sufficient only for the supply of troops engaged on the work. Further refinements will be undertaken only if additional time is available."

It may be stated at this point that all troops did actually work enthusiastically to the limit of their physical capacity and that of their equipment, and without regard to hours. The clearing operations at the heads of columns set the pace and were practically continuous. They did complete their assignments in one short season to a standard far higher than was believed possible when the preceding instructions were issued.

The Public Roads Administration, at the request of the Chief of Engineers, employed contractors to improve the pioneer road in rear of the troops, to construct certain mileage without the aid of troops, and to furnish various engineering services.

WINTER MARCH OF THIRTY-FIFTH ENGINEERS

From the railhead at Dawson Creek to Fort St. John there was a provincial dirt road passable in winter and dry weather. From Fort St. John to Whitehorse along the proposed route for nearly a thousand miles stretched a wilderness inaccessible for heavy equipment except over frozen trails in the winter months. There existed such a winter trail from Fort St. John to Fort Nelson, a distance of about 265 miles. This trail is generally over low, swampy ground and becomes impassable with the spring thaw, which may occur in early April. It was decided to send a regiment over this trail to Fort Nelson before the thaw with supplies sufficient for four months and to have this regiment work northwestward from Fort Nelson. In this manner another point of access was established, thus cutting off 265 miles from the longest inaccessible section of the route.

Typical Terrain Through Which the Alcan Highway Was Constructed

Selected for this difficult mission was the 35th Engineer regiment commanded by Col. Robert D. Ingalls, Corps of Engineers. The regiment, equipped with special arctic clothing, began arriving at Dawson Creek on March 10 and after many difficulties and hardships in weather 35 degrees below zero reached Fort Nelson on April 5 with all equipment and some 900 tons of supplies. For men inexperienced in such winter operations, this 325-mile march was a remarkable performance. Accomplishment of its mission by the 35th Engineers furnished the key to the early opening of the road to traffic.

ROUTE LOCATION

The second problem requiring early solution was the general location of the route. Although the road was to serve specified airports, the main road did not necessarily have to touch them, as they could be supplied if necessary by branch roads. Thus there was considerable latitude in location. Both the Army and the Public Roads Administration sent in exploring parties in February by automobile, airplane, and dog team. Joint parties were organized in several cases. It was soon apparent that the route of the winter trail to Fort Nelson was impracticable for an all-year road and that the higher ground to the west would have to be used, but this decision having been reached, this section remained the most difficult for detailed location as much of the route was in rolling, heavily forested country and did not always follow well-defined ridges or streams.

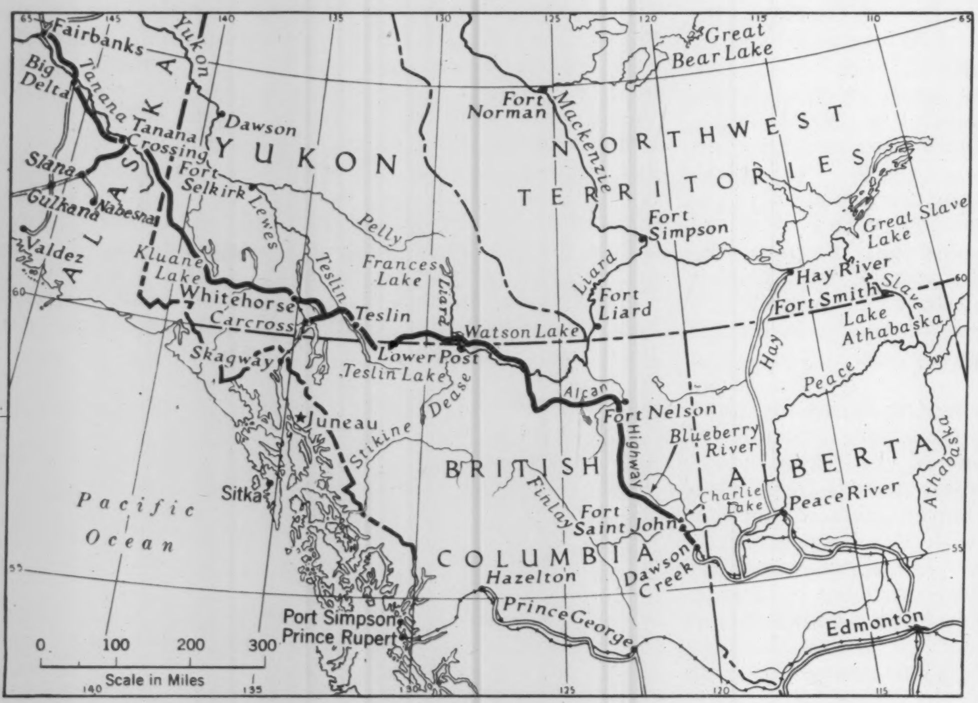
When the general route had been selected, the detailed location became a matter for the decision of regimental commanders on the ground, with the assistance of airplane photographs. Generally no more elaborate instruments than the compass and hand level were used on the ground. An early effort was made to have the engineers of the Army and those of the Public Roads Administration work together on detailed location in order that, in so far as practicable, the pioneer road might follow directly upon the location selected for the final improved road. This effort was soon abandoned because of the impossibility of supplying elaborate survey parties sufficiently in advance of the clearing operations to prevent delay in the latter. The Army units therefore located the pioneer road by reconnaissance methods, and even so had great difficulty in keeping ahead of the bulldozers in many localities. Time-consuming obstacles were usually avoided, a policy which resulted in some crookedness and excessive grades which will be eliminated in the final location. For these reasons the Public Roads Administration surveyors usually followed in the rear of the Army units and obtained data for relocations and grade corrections. In spite of the rapid methods used, the Army pioneer road was so well located that the bulk of its mileage will be improved directly to the standard of the final road.

COMPLETED HIGHWAY—THIS SECTION IS COVERED CORDUROY OVER MUSKEG

MOBILIZATION AND TASKS

Except for the early dispatch of survey and administrative personnel and the 35th Engineers for the special reasons previously indicated, there was nothing to be gained by sending in additional construction troops before the end of severe weather. The 35th Engineers, although on the ground on April 5, did not build much road during April, May, and early June because of heavy rains, floods, and the low wet ground extending west of Fort Nelson for 50 miles to Steamboat Mountain. After July 1, however, this regiment averaged 3 miles a day, and on September 24 had reached a point 305 miles from Fort Nelson, where it met the 340th Engineers working eastward from Teslin Lake.

Because the 35th Engineers would be inaccessible except by airplane until a road was opened to Fort Nelson, every possible effort was made to push this road through from Fort St. John. Two regiments, each with a strength of 1,290 officers and men, were assigned to this section. The 341st, under Col. Albert L. Lane, arrived about May 1 and led the way to Fort Nelson, which was reached on August



Fairbanks
Big Delta
Tanana
Tanana Crossing
Yukon
A L A S K A
Dawson
Y U K O N
Slana
Gulkana
Nabesna
Fort Selkirk
Lewes
Pelly
Valdez
Kluane Lake
Whitehorse
Carcross
Teslin
Teslin
Frances Lake
Liard
Skagway
Lower Post
Teslin Lake
Watson Lake
Dease
Juneau
Stikine
Sitka
Pacific Ocean
Fort Norman
Mackenzie
Great Bear Lake
N O R T H W E S T
T E R R I T O R I E S
Fort Simpson
Liard
Fort Liard
Great Slave Lake
Hay River
Slave
Fort Smith
Lake Athabaska
Hay
Peace
Alcan
Fort Nelson
Highway
Blueberry River
B R I T I S H
C O L U M B I A
Finlay
Fort Saint John
Charlie Lake
Peace River
A L B E R T A
Athabaska
Dawson Creek
Hazelton
Prince George
Port Simpson
Prince Rupert
Edmonton
0 100 200 300
Scale in Miles
65
145
140
135
130
125
120
115
110
60
55

FIG. 1. ROUTE OF THE ALCAN HIGHWAY

Rock Excavation in a Mountain Area

26, the bridge across the Muska near Fort Nelson being completed by detachments of a ponton company and the 35th Engineers almost exactly on the bour of the arrival of the regiment from the south. The 95th Engineer Regiment (colored) under Col. David L. Neuman and later under Col. Heath Twichell, arrived about June 1 and backed up Colonel Lane's regiment with culvert construction, grading, and drainage work, thus permitting the leading regiment to advance rapidly without too much danger of having its supply line bogged down.

The 18th Engineer regiment, under the command of Col. E. G. Paules arrived at Whitehorse on April 29 with part of its equipment and was assigned the mission of building the road northwest of Whitehorse. This regiment advanced rapidly until about August 1 for a distance of about 220 miles, after which it encountered very difficult going through permanently frozen ground. On October 25 it met the 97th Engineers working southward from Alaska at a point 313 miles northwest of Whitehorse.

Two other regiments, the 93rd and 340th, also arrived at Skagway in April. However, both regiments remained in Skagway until June awaiting arrival of their road-building equipment. The 93rd Engineers (colored) under the command of Col. Frank M. S. Johnson then moved to Carcross and at the end of July had constructed 99 miles of difficult road from that point to Nisutlin Bay on Lake Teslin. Part of the regiment then dropped back to improve its own pioneer road and the remainder improved the road constructed in the meantime by the 340th Engineers.

The 340th Engineers, commanded by Col. F. R. Lyons, moved in part via Carcross, over the road under construction by the 93rd Engineers and across country to Teslin River and thence by boat to Morley Bay on Lake Teslin, where it set up its base camp. The remainder of the regiment, with its heavy equipment, moved by steamer and barge down the Lewes River and up the Teslin River to Morley Bay. This regiment began work at this point late in June with part of its equipment. Working in both directions, it constructed the 9 miles of road between Morley and Nisutlin bays and by September 24 had crossed the Liard River near Watson Lake and had met the 35th Engineers at "Contact Creek," 240 miles east of Nisutlin Bay. It then dropped back to improve its own road.

The 97th Engineers (colored), under command of Col. S. C. Whipple and later under Lt. Col. L. E. Robinson, landed at Valdez, Alaska, in late May but could not get over Thompson Pass on the Richardson Highway until the middle of June. It then assisted the Alaska Highway Commission in repairing the Richardson Highway and moved to Slana on the Gulkana-Nebesna road, where it began construction of a road through Mentasta Pass in the Alaska Range at the end of June. This regiment proceeded through the pass with considerable difficulty due to frozen ground, and down the Tok River to the Tanana River. Crossing the Tanana it opened up the road along the north bank of the Tanana, crossed the international boundary, and met the leading elements of the 18th Engineers on October 25 in the vicinity of Beaver Creek, which is 194 miles from the starting point at Slana.

The Public Roads Administration was assigned all construction on the 114-mile section of the main route between the mouth of the Tok and Big Delta, and also the 50-mile section between Whitehorse and Jakes Corner.

SUPERVISION AND EQUIPMENT

For supervision and administration, two sector headquarters were established, one at Fort St. John controlling work southeast of Watson Lake, and the other at Whitehorse controlling the remainder of the work. Brigadier General William M. Hoge organized both offices and supervised all activities until June 6, when

Clearing with a Heavy Bulldozer

IN A MUSKEG SECTION

Col. James A. O'Connor assumed charge of the southern sector. Both sector commanders reported directly to the Chief of Engineers until the virtual completion of a route practicable for truck traffic. Enlarged plans for such traffic and extension of other projects in the region led to the organization of the Northwest Service Command under General O'Connor, who assumed charge in September.

All the seven regiments assigned to this project were similarly equipped, although in some cases delivery of complete equipment to the job was delayed. The principal items of interest included, for each regiment, twenty D-8 diesel tractors and bulldozers; twenty-four D-4 and R-4 tractors with bulldozers and trailers for their transportation; three motor patrols; from fifty to ninety dump trucks; various cargo trucks; eleven to twenty $^1/_4$-ton trucks (jeeps); twelve pick-up trucks; two $^1/_2$-cu yd gas shovels; one truck crane; six 12-cu yd carryalls; six tractor-drawn graders; one portable sawmill; and two pile drivers. In addition each regiment carried the normal assortment of small tools, water purification equipment, and electric lighting plants. Each company was provided with a radio receiving and sending set mounted in a jeep.

Nearly all the foregoing equipment was new, which proved very fortunate as spare parts were often unobtainable and repair facilities were inadequate. Much ingenuity was displayed in keeping equipment in operation, but at the end of the season much of it was on the dead line awaiting repairs or parts.

SEQUENCE OF OPERATIONS

In the typical operations of a regiment engaged in breaking new trail through the forest, we find in the lead, of course, the locating party which indicated the center line by blazes or pieces of cloth. The clearing crew with three shifts of tractor operators followed. One large bulldozer ran along the marked center line clearing a narrow trail. Other large machines were then assigned tasks along this trail. Pushing the trees laterally to both sides, they made a clearing from 60 to 90 ft wide. Having finished a task, a bulldozer would leap-frog forward to its next similar task. On much of the route the forest growth was dense but the trees were usually not large or deeply rooted. Where the ground was firm, ten or twelve bulldozers could clear two to three miles through solid forest each day. The smaller bulldozers were used to follow the large tree movers cleaning off moss, muck, and lesser debris. The clearing crew was generally several miles beyond the reach of trucks and had to be supplied by pack train, tractor-drawn sleds, or trailers. The men slept in pup tents and moved camp nearly every day.

A crew consisting generally of a company followed the clearing crew and constructed log culverts and small bridges. This was followed in turn by another crew engaged in ditching, corduroying if necessary, and rough grading sufficient to permit passage of truck traffic in weather not too wet.

The remainder of the regiment, perhaps two or three of the six companies, might be distributed along the road 30 or 40 miles in the rear of the clearing crew, and be engaged in widening the narrow places, reducing the worst grades, graveling soft spots, and smoothing with motor patrols. This operation completed the pioneer road, which was generally 18 to 24 ft wide. As means permitted later in the season, still further improvements in grade and alinement were undertaken both by Army and Public Roads Administration forces. The road has now received a light surfacing with gravel over its entire length.

Two light ponton companies, each equipped with 675 ft of floating bridge material, were parceled out to the regiments. The ponton detachments promptly put in floating bridges over streams that could not be forded, or ferries where available material was insufficient for bridges. Pile or trestle bridges were constructed as soon as possible to release the ponton equipment.

LOCATION ALONG STREAMS WAS DESIRABLE FOR HERE FIRM GROUND WAS USUALLY FOUND

RATE OF PROGRESS

Rate of progress is best indicated by the mileage under construction at the end of each month, since the road was usable for supply purposes in a very short time after clearing was completed. Such progress is indicated in Table I.

In conclusion it is believed that nobody can really appreciate the volume of work accomplished without actually making a trip over the road. The main difficulty proved to be supply rather than construction.

Progress would have been still better except for lack of adequate water transportation to Alaska, which delayed the start of effective work in the Whitehorse area. Much delay was also due to the scarcity of certain supplies resulting from war conditions, particularly spare parts for transportation and construction equipment.

The credit for pushing this road through the wilderness in the short span of one working season belongs first and foremost to the ten-thousand-odd American soldiers who took their fine equipment and did the job. This statement does not overlook the excellent and necessary work accomplished by the civilian forces of the Public Roads Administration in following up the troops and improving the Army road.

TABLE I. MILEAGE UNDER CONSTRUCTION

To Date Indicated	Miles	Remarks
April 30	8	By 35th Engineers
May 31	95	By 4 regiments
June 30	360	By 7 regiments
July 31	794	By 7 regiments
Aug. 31	1,186*	Fort Nelson reached Aug. 26
Sept. 30	1,479*	Road passable to Whitehorse Sept. 24
Oct. 25	1,645*	Road passable to Fairbanks

* Includes Public Roads Administration construction.

These soldiers of ours worked early and late. Neither heat nor cold nor all the challenges of the pathless wilderness could stop them. During March the men braved bitter winds and temperatures of 35 below. In July and August, gloved and swathed in netting against swarms of mosquitoes, flies, and other insects, they sweltered under 90-degree heat. The rainy weather found them slogging through bottomless mud. They threw into their job the same spirit and the same courage that their comrades-in-arms have thrown into the operations in Algiers, in Morocco, and at Guadalcanal. Yes, America can well take pride in the way its soldiers have performed in the building of the Alcan Highway.

Problems of Location

By ALBERT L. LANE

COLONEL, CORPS OF ENGINEERS, U.S. ARMY, WASHINGTON, D.C.

On November 20, 1942, there stood at a remote point near the Yukon-Alaska border, in subzero weather, a group of soldiers and civilians. A ceremony was in progress—the formal opening of the Canadian–Alaskan Military Highway. Winding far ahead into obscurity and reaching back beyond the range of vision, stretched over 1600 miles of the new route.

The value of such a connecting link with Alaska had long been recognized by our government, but the critical need for it was thrust upon us by the war. Such a supply line was needed, and needed at once. Speed was the key word. The efficiency and dispatch with which the many complex problems associated with the initial phases of the project were disposed of mark a new high in the demonstration of American ingenuity and resourcefulness. In this discussion it is proposed that consideration be given to only one phase of the project, specifically, the location of the road itself in so far as it was the particular problem and responsibility of the unit work party commander.

Selection of the general route by the War Department was based primarily on military considerations and the final location differed widely from that of any route proposed prior to the war. The major portion of the new route passed through a wilderness region, most of it unsurveyed and unknown.

Each troop unit was responsible for the location of its specific section of road and in each section location problems varied considerably. This paper will be devoted principally to the location of the 265-mile Fort St. John–Fort Nelson sector, that with which the writer is most familiar. Although each section had its own peculiar location difficulties, based principally on characteristic terrain features, a description of a few of the problems encountered on the Fort Nelson–Lower Post Section will give a fairly accurate picture of the almost insuperable difficulties that had to be surmounted in putting through this route.

STEREOGRAM SHOWING VARIOUS TYPES OF VEGETATION

The Fort St. John–Fort Nelson section first traversed some fifty miles of forest and muskeg lowlands, then progressed along streams, into river valleys, and through mountain passes in the heart of the Canadian Rockies, eventually terminating in a glaciated region pockmarked by huge depressions several hundred feet deep and up to five miles in diameter. Major considerations in this sector were the selection of the most desirable river valleys and mountain passes to traverse the Rockies. The decisions were eventually determined from aerial reconnaissance, which necessitated numerous flights.

As construction progressed, an old Indian trail was discovered, which proved to be an excellent guide towards the objective. Generally information from Indian guides could be used only with caution as their knowledge of the areas was surprisingly limited. One guide in particular reported the existence of a desirable route through the mountains, authoritatively emphasizing that "Indian way take one summer, white man way take two summers." The investigation of this supposedly desirable route alone required the services of a reconnaissance party for most of the summer.

Location through the first fifty miles of lowlands east of the mountains was accomplished principally by following a narrow strip of good ground, the presence of which was indicated by a belt of poplar growth. Low-altitude flights were made over this area, taking azimuths of the various tangents from the instrument panel com-

Timber Stream Crossing at a Minor Control Point

pass, and estimating distances by calculating the speed of the plane by stop-watch. Aerial photographs would have provided an easier solution but owing to lack of time, poor flying weather, and the urgent need for the photographic plane elsewhere, photographs were not available. It was this section that disturbed certain critics into advertising that this entire area consisted of 250 miles of swamp and bottomless bog. It is true that soundings made some years previously progressed to a depth of 80 ft without finding any sign of bottom. It is interesting to note that the first copies of publications proclaiming the impossibility of construction in such muskeg swamps reached Fort Nelson on August 27, the day after the road from Fort St. John had broken through.

The unit assigned to this section arrived at Fort St. John early in May 1942. The fall of 1941 had been especially wet, and the ground had become thoroughly saturated with water which had remained frozen during the entire winter. As late as May it was only commencing to thaw, creating a mucky, slimy surface that impeded ground traffic of all kinds, and made any type of ground reconnaissance exceedingly difficult.

Very few maps of the region were available and even on these, large areas had never been charted. Some areas had been charted from reports of guides and trappers, in many instances with striking inaccuracies. Generally speaking little was indicated of the terrain features that would determine the selection of a desirable route. Some of the better maps contained such vague notations as "reported verdant valley, one mile wide, twenty miles long." No guides, trappers, or Indians who had comprehensive knowledge of any extensive areas could be discovered.

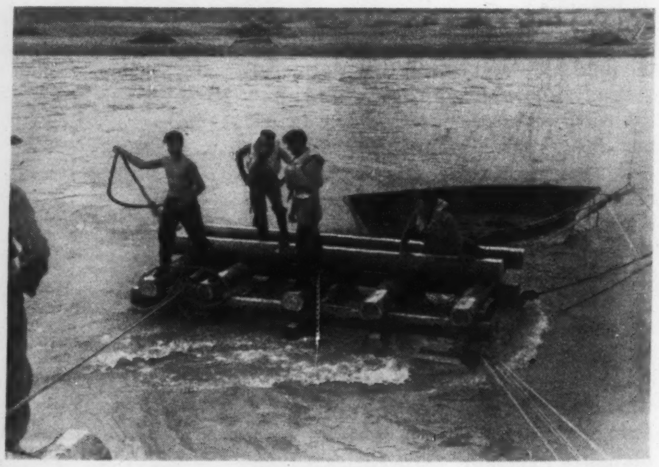
GOOD TRUCK ROUTE INSTEAD OF A "PIONEER ROAD"

It was originally planned that Engineer troops would build only a "pioneer road," which would permit contractors operating under the PRA to move men, equipment, and supplies into position for the construction of a first-class modern highway. Reconnaissance of a possible route between Fort St. John and Fort Nelson had been made by a dog-team party of the Public Roads Administration during the previous winter. By the middle of May, the PRA was organizing a number of parties to make the preliminary and final location surveys for its own highway.

A combined Army and PRA reconnaissance party using pack trains started out to establish a general line for both the Army "pioneer road" and the PRA final road. This party used a sizable hand-clearing crew to hack a pack trail over which a transit and stadia survey line was run, to serve as a rough guide for the final location. However, the critical factor throughout was time, and the plotted courses of this survey were not received in time to be of much use in locating the pioneer road. As a result most of the initial locating was made by officers and men walking many miles, selecting a route where soil and drainage would permit the building of an immediately serviceable road with the equipment on hand and with the maximum conservation of time.

The first thirty miles of the road was experimental, both in location and in construction methods. Since the heavier bulldozers needed in the advance clearing operations did not arrive on the job until the experimental section was practically completed, most of the right of way was hand cleared. The work was under way only a short time when it became evident that a good two-track 26-ft roadway could be constructed quickly by the troops without loss of valuable time. The need for such a truck route was emphasized by the situation confronting the unit working northwest from Fort Nelson, which was isolated with the coming of the thaw and had supplies for only four months. The decision was then made to construct a well-drained, well-graded truck road instead of the originally proposed "pioneer road." This decision naturally altered location plans to some extent.

About the middle of June the heavy dozers arrived on the job and were immediately dispatched to the advance clearing crews. As a result their progress became so rapid that they soon caught up to the combined Army and PRA reconnaissance party, which up to that time had located an average of one mile a day. It then became imperative to find a speedier method of location, since the Army was geared to a rate of construction of at least three miles a day. This brought about the adop-



Setting a Crib Pier in a Swift Stream

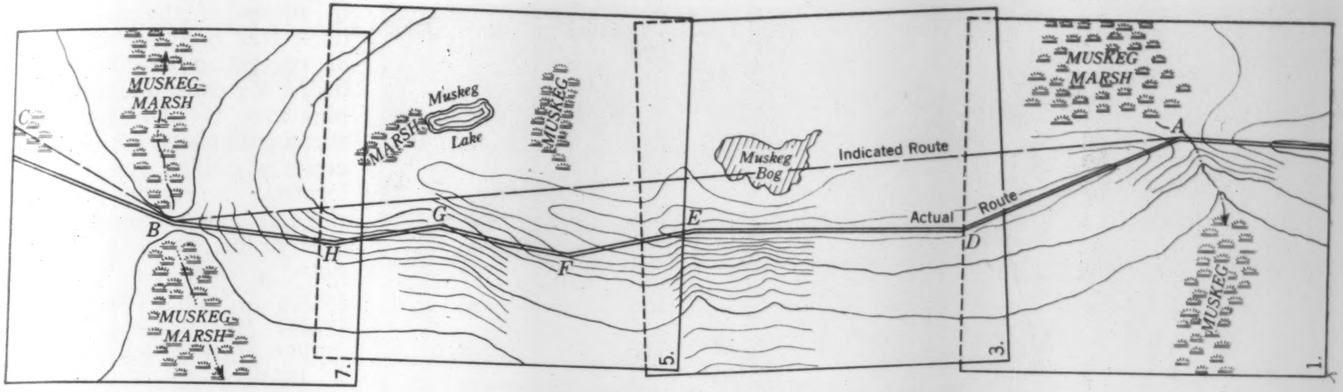


Fig. 2. Aerial Photographs Oriented to Locate Line of Highway

tion of aerial photography which had been deliberated upon earlier in the spring, but not adopted because of the lack of a photographic plane and later adverse flying conditions. With the availability of a photographic plane and the advent of better flying weather, additional problems presented themselves. These included particularly the absence of reliable maps on which to lay out proper flight diagrams to insure coverage of desired areas. Furthermore, in the dense forest tracts, there were few visible landmarks on which pilots could orient themselves so as to bear on pre-selected courses. As a result there were frequently large gaps between the aerial photographic strips, and the desired road location often fell in these gaps. At such times it was necessary to resort to the old-time field reconnaissance methods of plotting sketches from data secured by running out compass courses and counting strides.

ROAD LOCATION BY AERIAL PHOTOGRAPHS

On the Fort St. John–Fort Nelson section, tentative routes were selected from numerous aerial reconnaissance flights, then a series of photographic strips were secured giving as complete coverage as possible of all areas to be considered. An intensive study of these photographs, coupled with information gained by questioning local guides, trappers, and Indians, and supplemented by data obtained from additional reconnaissance flights, directed the decision as to the routes that should be investigated to determine the final location.

It must be emphasized again that speed in construction was the predominant factor. Terrain such as this—with its tumultuous foothills, large muskeg and swamp lands, deep ravines, and drainage that lay at right angles to the route location—required exhaustive examination, since any route that called for extensive stream-crossing expedients, sizable earth-moving, and comprehensive muskeg passages had to be avoided. The size and density of growth were of minor importance since they offered no obstacle to the heavy bulldozers.

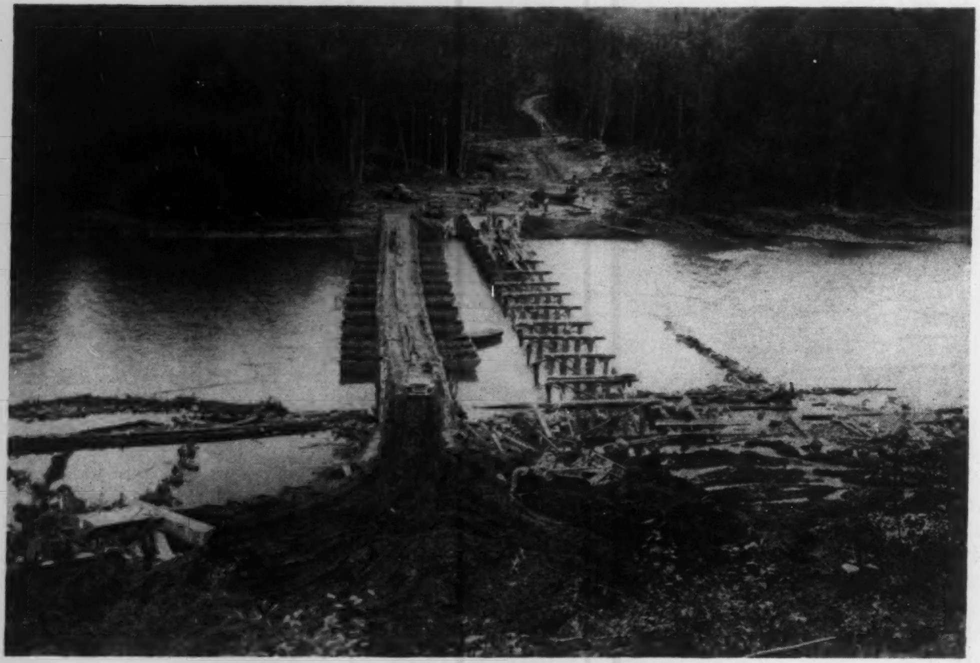
Soil conditions were important but the underlying soil was practically the same throughout this entire region—meager traces of rock, and almost no sand or gravel except in the river beds. Therefore the effect on location was negligible. The soil did, however, dictate the construction scheme by necessitating extensive well-graded ditches, since the characteristic soil was a fine, firm clay which packed into solid impervious beds allowing no subsoil drainage.

As a result of these investigations a general location of the road was determined, consisting primarily of certain major control points such as suitable river crossings and passages between large muskeg tracts—points through which the road should pass because of reduced construction requirements. These were further examined by ground reconnaissance, the parties being flown in, packed in, or paddled in. The next step would correspond to the preliminary survey. Under the old procedure, survey parties would have been sent into the field to make a detailed study and probably a strip contour map of the ground over which the road was expected to advance. In this instance a road location was developed by examining stereopairs through a good mirror stereoscope.

Aerial photographs for ideal stereoscopic study should be dull finish, clear, and taken with approximately 60% forward overlap, at a scale of approximately 1:12,000. They should afford sufficient coverage on each side of the general route to permit the investigation of any necessary minor deviation without resort to ground reconnaissance, or new flight strips. Figure 2 illustrates the mechanics of this location operation.

One of the fundamentals in road location is the

Corduroy Placed in a Muskeg Section



Permanent Bridge Replacing a Ponton Structure
The Ponton Crossing Was Placed in Half a Day

principle that, other things being equal, the straightest line from one terminus or control point to the other is most desirable. In Fig. 2, *A* and *B* are control points through which the road must pass. In the interest of preserving direction, and to reduce the area in each stereopair that must be examined under the stereoscope, alternate photographs of the flight strip (in this instance numbers 1, 3, 5, and 7) are laid out by matching detail in the 20% overlap area. Then the general directional route *AB* is drawn between the major central points, as indicated by the dashed line in Fig. 2.

Alternate photographs are used in order to avoid covering up essential detail by having the directional line appear on every photograph. The stereopairs are now examined under a mirror stereoscope, and the road is located so as to best fit it to the ground and to diverge as little as possible from the indicated route *AB*. Note that any line drawn on one photograph of a stereopair is visible in the stereoimage. Thus the line *AB* may be seen in this image even though it is drawn only on the alternate photograph of each stereopair. Now assume that the road has been located as far as control point *A*. Normally, one would take the first stereopair photographs, and continue from point *A* to point *B* by means of a series of tangents, as indicated by the lines *AD*, *DE*, *EF*, *GH*, and *HB*.

REGIONAL FACTORS ALSO CONSIDERED

Certain factors that are peculiar to the region govern the actual location. Prevailing winds are from the southwest and the sun also has its greatest drying effect from that same direction; therefore locations on the south or southwest slope of a ridge should be sought. Of maximum importance is a study of the vegetation, which will indicate that definite soil and drainage characteristics support distinctive types. For example, dense growths of small-sized spruce suggest muskeg, while large spruce, willow, alder, and buck brush predominate in wet ground. Jackpine and poplar growths usually indicate good soil and satisfactory drainage. The accompanying stereogram, arranged for stereoscopic study by means of the naked eye, illustrates how various types of vegetation may be identified. A growth of small jackpine may be identified along the top of the ridge near the crest of which the road is located. Lower down on the ridge, where the most favorable drainage exists, will be noted a band of light-colored poplar. Near the base of the ridge it will be noted that large spruce are gradually replaced by muskeg spruce.

Under the old standard survey method, the third step would be the location survey, usually consisting in the transfer of the preliminary map location to the ground. Under the newer method, the road location on the photographs is transferred to the ground. Having located point *A* on the ground and having secured the azimuth of the tangent *AD*, the party chief and one man checked the suitability of the ground for road location. When unsuitable gravel was encountered, it was necessary to go back to point *A* and start with a new tangent of slightly different azimuth so as to by-pass the undesirable section.

Pressure from the clearing operations, necessitating "more line," on occasions forces a resort to improvised methods of running in compass line. Frequently in old burns, where fallen timber and thick bush make foot travel exceedingly difficult, long sections of line were run by actually working with the lead dozer of the clearing crew. The dozer was directed towards some distant landmark that was on the compass course and also visible above the bush to anyone standing on the dozer. Often it was necessary to climb trees on the line in order to spot such a landmark, as the compass bearing from the dozer itself was unreliable because of magnetic interference. In areas blanketed by exceedingly dense growths of small jackpine thickets, location was expedited by placing men on line who would locate themselves by shouting back and forth. The head man would then guide the dozer operators towards the line by shaking a tree, and once on the line, the dozer operator would be further guided by the men previously placed.

A perplexing problem that frequently arose was occasioned when the road location line ran off the photographs. When this happened standard foot reconnaissance methods became necessary, although it was extremely difficult in this region of heavy forest, swamps, and windfall areas. Often a good hunch as to the proper direction to follow proved valuable. Generally, however, it was necessary to climb numerous trees and to trudge many miles in an effort to determine the lay of the country. On numerous occasions members of foot survey parties were lost for several days.

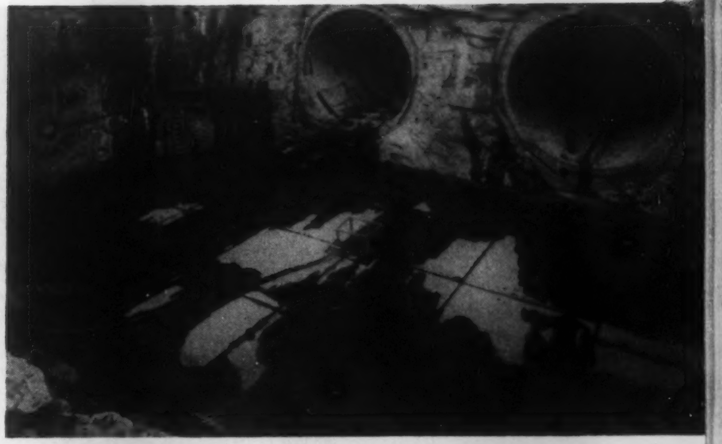
It is believed that a modification of the aerial photographic method as outlined could be used to good advantage on any state or federal highway project. For smaller jobs, the multiplex projector contour map would not be necessary and one set of flight photographs should suffice for locating both the tentative and the final route.

Lining Inclined Section of Delaware Aqueduct

By CHARLES G. HOERNER, M. AM. SOC. C.E.

SENIOR SECTION ENGINEER, BOARD OF WATER SUPPLY, CITY OF NEW YORK

WATER from three Catskill Mountain streams will be brought to New York City through the 85 miles of the Delaware Aqueduct. The construction of this pressure tunnel involved many interesting problems, among them the concreting of a section of inclined tunnel 3,040 ft long. This operation is here described by Mr. Hoerner. Previous articles in the September 1938 (p. 581) and August 1942 (p. 449) issues discussed the tunneling methods used on the aqueduct job.



EXCAVATION FOR RONDOUT EFFLUENT CHAMBER
Two 28-Ft-Diameter Stilling Chambers and Blowoff Tunnels Shown

THE latest addition to New York City's water supply system includes 85 miles of pressure tunnel, known as the Delaware Aqueduct, which is now in its final stages of completion. The aqueduct is divided into three main links to take advantage of the benefits of deep storage at existing reservoirs. The northernmost link, known as the Rondout-West Branch Tunnel, is about 45 miles in length. The Inclined Tunnel, here described, is at the upper end of this link between Shaft 1 and the Rondout effluent chamber. The latter might be termed the nozzle of the reservoir.

Water from the Rondout Reservoir, after passing through trash racks, screens, and other operating equipment installed in the Rondout effluent chamber, enters two stilling chambers (Figs. 1 and 3) each having a finished diameter of 28 ft and a length of about 86 ft. The water leaves each stilling chamber at the top by means of a gooseneck connection which tapers off in diameter to 13 ft 6 in. From this point short twin tunnels merge into the inclined section through a series of transitions.

The lower end of the inclined tunnel was submerged at all times and cataracting was prevented. For the release of entrained air, a local conical enlargement in the diameter of the shaft from 14 to 40 ft was made through a depth of 102 ft at this level. With the grade of the tunnel substantially fixed by distance and elevation, velocities were kept within safe limits by increasing the wetted perimeter, which resulted in an increase in the section area and the introduction of the longitudinal concrete vanes. The final design was based on a series of tests made on models constructed of the prototype from the Rondout effluent chamber to Shaft 1.

CURB-WALL CONCRETE PLACED FIRST

After invert mucking of the inclined section had progressed 2,200 lin ft, the curb wall was started down grade toward Shaft 1 (Fig. 1). This work was done only on one shift per day, the carpenters keeping ahead of the concrete gang. The curb wall was continuous for the 13-ft 6-in. tunnel and for about 300 ft on each end of the 15-ft 6-in. tunnel. The intermediate portion was built as piers 3 ft wide, spaced 15 ft on centers, along the slope and set on the same line and grade as the continuous curb.

Concrete was transported from the drop pipe in two side-gate 2-cu yd hoppers, each mounted on a flat car and lowered by the hoist to the forms. The concrete was placed directly from the cars to the forms by chute. The average weekly progress was 502 lin ft of tunnel, and the maximum was 810 ft.

Accurate line and grade for the curb wall was obtained by setting a 3 by 10-in. timber on edge along the inside face of the forms and screeding the concrete even with the top. Vertical 1-in. boards were set at random heights from the irregular surface of the rock. As the track was not suitable for lateral bracing, the top of the form was held to line by setting hook bolts, with turnbuckles, in drilled holes in the rib. At the bottom, where the rock afforded no means of bracing, steel pins were used. In the 13-ft 6-in. tunnel sections, $^3/_4$-in. screw anchors were set at 40-in. intervals to hold the invert forms. No anchor bolts were set for the flume-wall section.

No bridge or traveler was used for the invert in the 13-ft 6-in. tunnel, the concrete being placed by a pumpcrete machine (Fig. 2) with a rotary remixer set up at Sta. 33 + 0. The 8-in. discharge line, with a maximum length of about 880 lin ft for the first pour, was run along the curb wall to the forms, where it was supported on 3 by 12-in. timbers across the forms. The length of a pour varied from 72 to 155 ft. An average pour of 117.4 lin ft took 89.2 cu yd and 4 hours and 40 minutes to fill, and the entire 859 lin ft was concreted in 10 days elapsed time. Operations started at Shaft 1 and progressed up grade with two shifts a day. Concrete was poured and forms set ahead on the 8:00-to-4:00 shift; washing and cleaning of invert and work on plant was done on the 4:00-to-midnight shift.

The side forms, consisting of $^3/_{16}$-in. plate bent in the form of a bracket, came in 10-ft lengths and were bolted to the top of the curb wall by means of the $^3/_4$-in.-diameter screw anchors set in the curb wall, permitting a height of 1.36 ft to be poured. This was equivalent to a central angle of 74°.

The screed for the invert concrete was 10 ft long and consisted of $^1/_4$-in. plate reinforced with 6 by 4 by $^3/_8$-in. angles, made to conform with the curve of the waterway. It rode on two sets of 10-in.-diameter wheels, with roller bearings, along the top of the form, which acted as its track. A three-man finishers' platform made up of two 3 by 3 by $^1/_4$-in. angles spaced 3 ft apart, with timber

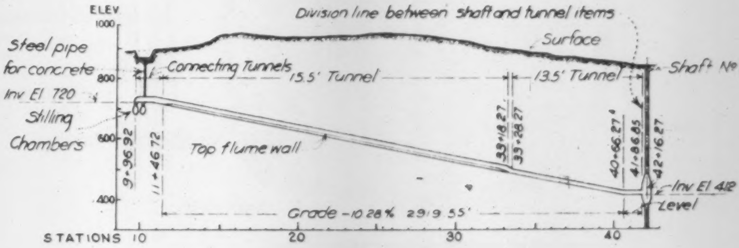


FIG. 1. PROFILE OF INCLINED TUNNEL

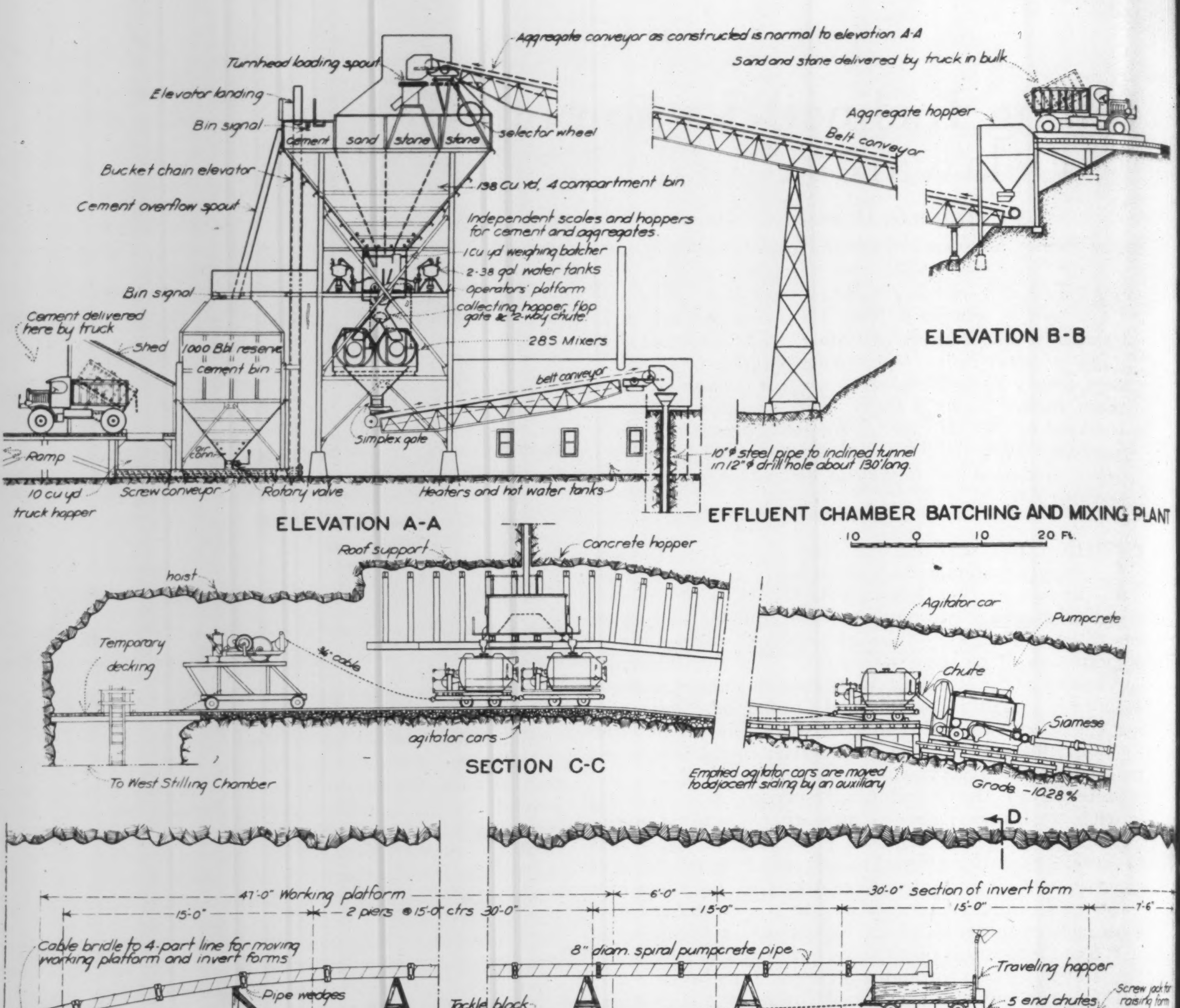

Aggregate conveyor as constructed is normal to elevation A-A
Turnhead loading spout
Elevator landing
Bin signal
Cement
sand
stone
stone
selector wheel
Bucket chain elevator
138 cu yd, 4 compartment bin
Cement overflow spout
Independent scales and hoppers for cement and aggregates.
1 cu yd weighing batcher
2-38 gal water tanks
Operators' platform
Bin signal
collecting hopper, flap gate & 2-way chute.
Cement delivered here by truck
Shed
1000 Bbl reserve cement bin
28 S Mixers
belt conveyor
Simplex gate
Ramp
10" φ steel pipe to inclined tunnel in 12" φ drill hole about 130' long.
10 cu yd truck hopper
Screw conveyor
Rotary valve
Heaters and hot water tanks
ELEVATION A-A
Sand and stone delivered by truck in bulk
Aggregate hopper
Belt conveyor
ELEVATION B-B
EFFLUENT CHAMBER BATCHING AND MIXING PLANT
10 0 10 20 Ft.
Roof support
Concrete hopper
hoist
Temporary decking
¾" cable
agitator cars
To West Stilling Chamber
SECTION C-C
Agitator car
Pumpcrete
Chute
Siamese
Emptied agitator cars are moved to adjacent siding by an auxiliary
Grade -10.28%
D
47'-0" Working platform
15'-0"
2 piers @ 15'-0" ctrs 30'-0"
6'-0"
15'-0"
30'-0" section of invert form
15'-0"
7'-6"
Cable bridle to 4-part line for moving working platform and invert forms
8" diam. spiral pumpcrete pipe
Traveling hopper
Screw jack for raising form
Pipe wedges
Tackle block
5 end chutes
Tie angle
2-12" ⊏s @ 20.7#
Invert form carrier rail
Concrete piers for carrier rail
Temporary timber rail support
3'-0"
D
CONCRETING INVERT AND FLUME WALLS
4 cu yd concrete hopper side dump and chute blocked up on car
7'-9" Rad
11'-0" Rad
4'-8½"
4" Comp air
2" Water
Carrier rail
Lagging placed vertically
7'-9¼"
36" gauge track
CURB FOR INVERT FORM CARRIER RAIL
Half section of steel forms in position
Half section of form in raised position
7'-9" Rad
8" Dia Pumpcrete pipe
Traveling hopper 5 end, 2 side chutes
Removeable side chute
Screw jack for raising form
Collapsing ratchet and wood wedges
Wood side form
Anchorage for reinfo
Rods at angle spot we
SECTION D-D
INVERT AND FLUME WALL FORM

FIG. 2. SECTIONAL ELEVATIONS OF PLANT AND EQUIPMENT FOR CONCRETING

placed between to form a floor, rode on two sets of 6-in.-diameter wheels with roller bearings, and followed behind the screed platform.

WATER IN TUNNEL BYPASSED

Concrete was brought from the drop-pipe hopper to the pumpcrete machine by four 4-cu yd agitator cars in trains of two cars each, which were lowered in two stages. The hoist between the stilling chambers lowered the train to the California switch whence it was picked up by the stationary hoist and lowered to the pumpcrete machine. The cars emptied directly into the pumpcrete machine, and while this was taking place a train of two empties was pulled up the tunnel to the hopper. As the invert was filled, the screed platform was moved ahead or uphill by means of an air-driven utility hoist placed on the up-grade side of the bulkhead.

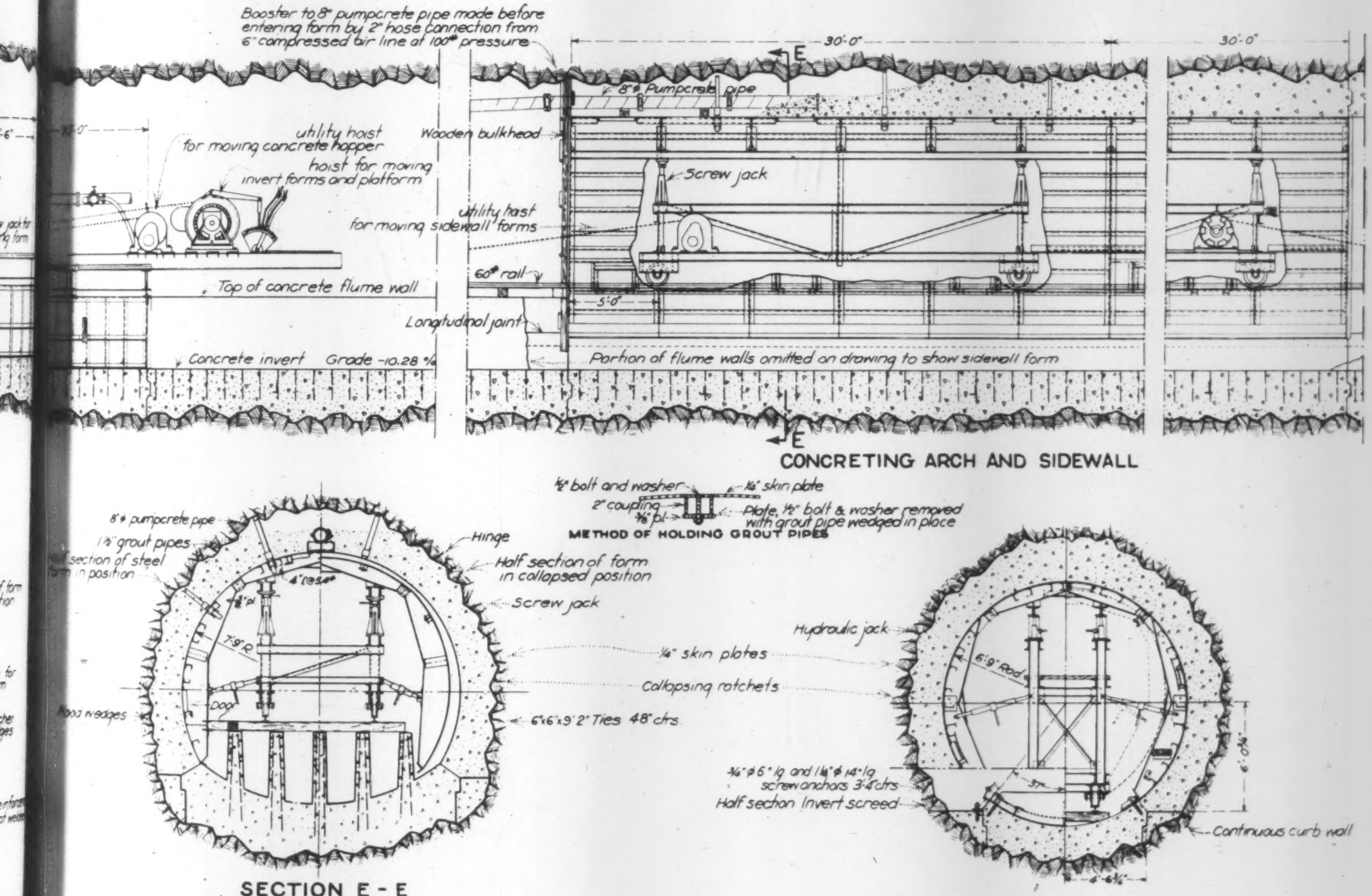
Water which flowed down the tunnel was handled by means of a sand-bag dam placed in front of the invert-bulkhead, and bypassed around the section being poured by means of an electric portable pump, which discharged into a 3-in. pipe set on the curb wall. The water then ran along the curb wall to the shaft to a sump left in the invert.

A few days before the completion of the invert, 60 ft of side-wall and arch forms were brought into the tunnel from Shaft 1. These forms were originally designed for continuous concreting, but on this job the contractor decided to use bulkheads. The forms consisted of twelve 5-ft panels of three segments each, overlapping the invert. Each form was anchored to the invert by means of 1¼-in.-diameter screw anchors spaced 3-ft 4-in. apart, the inserts of which were set in the invert while it was being poured. Thirteen shifts were spent erecting the forms and setting them on the carriage, which traveled on a 36-in.-gage track having timber ties resting on the invert. The carriage was moved by means of a hoist mounted on it at the upper end, with snatch blocks anchored along the rib above the form.

Concrete for roof and walls was poured up grade from the shaft using the same equipment and methods as for the invert. No set schedule of operations was followed during the first two weeks of pouring, in which the contractor made only 6 pours. Operations were then organized so that washing and cleaning of rock, moving and setting of forms and grout pipes, were done on the "graveyard shift" and concreting on the following or day shift, so that a pour could be completed each day. Weekly progress averaged 220 lin ft, with a maximum of 299 lin ft. The pours averaged 202 cu yd for a net length of 59.6 ft, and took 7 hours to complete.

CONCRETING INVERT INTEGRAL WITH FLUME WALLS

The forms provided by the contractor for the 15-ft 6-in. diameter tunnel were built by the Blaw-Knox Company especially for this part of the work. They were 60 ft in length and were constructed to permit the flume walls to be poured monolithic with the invert. The forms, supporting bridge and appurtenant additions, are shown in detail in Fig. 2. The setting of the reinforcement in

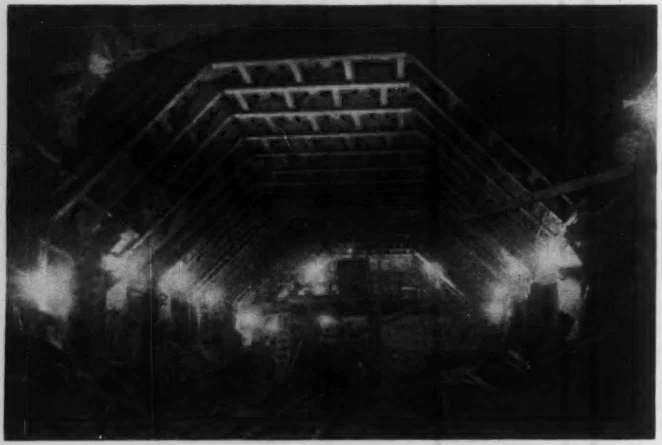

Booster to 8" pumpcrete pipe made before entering form by 2" hose connection from 6" compressed air line at 100# pressure
30'-0"
30'-0"
E
8"ϕ Pumpcrete pipe
utility hoist for moving concrete hopper
hoist for moving invert forms and platform
Wooden bulkhead
Screw jack
utility hoist for moving sidewall forms
60# rail
Top of concrete flume wall
5'-0"
Longitudinal joint
Concrete invert Grade -10.28 %
Portion of flume walls omitted on drawing to show sidewall form
½" bolt and washer
¼" skin plate
2" coupling
⅜" pl
Plate, ½" bolt & washer removed with grout pipe wedged in place
METHOD OF HOLDING GROUT PIPES
8"ϕ pumpcrete pipe
1½" grout pipes
Half section of steel form in position
Hinge
Half section of form in collapsed position
4" res 4"
⅜" pl
Screw jack
7'-9" R
¼" skin plates
Collapsing ratchets
Door
Wood wedges
6"x6"x9'2" Ties 48" ctrs
Hydraulic jack
6'-9" Rad
¾"ϕ 6" lg and 1¼"ϕ 14" lg screw anchors 3'-4" ctrs
Half section Invert screed
6'-0¾"
Continuous curb wall
4'-6¾"

CONCRETING ARCH AND SIDEWALL

SECTION E - E
ARCH AND SIDEWALL FORM

13'-6" DIAM. TUNNEL FORMS

THE INCLINED TUNNEL (SEE FIG. 3 FOR LOCATION OF SECTIONS)



STEEL SUPPORTS WERE USED IN SECTION OF TUNNEL DRIVEN THROUGH FAULTED ROCK

the flume walls presented a problem in that a method had to be found to set and hold the rods in position before and during concreting. The top width of the flume walls was 8 in., and the reinforcement formed a grid along each side. The contractor solved the problem by erecting the rods ahead of the forms by welding one of the vertical rods of each grid to the long leg of 6 by 4 by $^3/_8$-in. angles set approximately 15 ft on centers transversely across the tunnel below the forms and anchored to the curb walls or supplementary piers. In addition, vertical rods every 5 ft were extended to rest on the rock floor to eliminate sag between the welded supports. The horizontal and vertical rods were wired together. To keep the grid at a fixed distance from the forms, small mortar blocks were cast with haywire inserts to hold them in position at the top and bottom of the flume walls with the addition of a spreader mortar block at the top with a wire insert at each end.

The pumpcrete machine was moved from Sta. 33 + 0 to Sta. 20 + 40, and when the invert construction had reached this station the side wall and arch was brought up to or near the completed invert and the pumpcrete machine moved to Sta. 10 + 50, from which location the invert and flume walls were completed. With the pumpcrete machine at Sta. 20 + 40, the agitator cars were lowered singly. A utility hoist located on the left side of the tunnel switched the emptied car to the main track to permit the loaded car the right of way. While this car was discharged into the pump, the empty car was raised to the drop-pipe hopper.

With the pumpcrete machine located at Sta. 10 + 50, the concrete from the 10-in. drop-pipe hopper discharged directly into the rotary mixer of the pump by means of a short section of 14-in. pipe. The pump discharged on a movable timber platform with side boards, openings being provided over each flume wall through which the concrete was shoveled by hand. The platform was moved by a utility hoist on the invert form. The maximum size aggregate used in the flume walls was $^3/_4$ in.; the larger or $1^1/_2$-in. size was used in the invert. After an initial placement of 60 batches with the large-size aggregate, the pour was completed by alternately mixing 10 batches with the $^3/_4$-in. aggregate and 20 batches with the large-size aggregate. The forms were moved by a hoist set on the down-grade end of the invert form, the cable running from the hoist under the platform to pulleys anchored along both side walls beyond. As the form was moved ahead, the rail was supported by blocking between piers, but in its final position a set of wheels was always placed directly over a pier.

Progress was slow for the first two weeks, owing to the necessity of overcoming the difficulties with the setting of the steel, transition to the flume walls, and improvements that had to be made to the forms because of the steep grade. Operations were first on a 3-shift basis—concreting on the day shift; cleaning and washing rock, setting reinforcing steel ahead on the 4:00-to-midnight shift; and moving and setting forms on the midnight-to-8:00 shift. As the work progressed, the force was reduced to 2 shifts by concreting and setting the reinforcing ahead on the same shift. The average weekly progress was 295 lin ft; the maximum was 357 lin ft. An average pour of 59.4 ft contained 182.3 cu yd and was completed in 5 hours and 40 minutes.

SIDE-WALL AND ARCH FORMS

When the invert and flume walls were completed to Sta. 22 + 01, 6 by 6-in. hardwood ties 9 ft 2 in. long were laid on 4-ft centers, and the rails laid for a 36-in.-gage track. Sixty feet of Blaw-Knox steel forms were erected for the side wall and arch and poured as a unit with the traveler of this form riding on a track of 5-ft 10-in. gage, which was set by spreading the existing rails as the form was moved ahead. The form was set in position, as shown in Fig. 2, by the screw jacks, after which the weight of the form was allowed to rest on the finished invert. The form was fitted with an angle at the bottom, and at this point of contact, a break in the radii of the periphery made a bearing possible. No bolts were used to anchor the forms to the invert. The carriage was

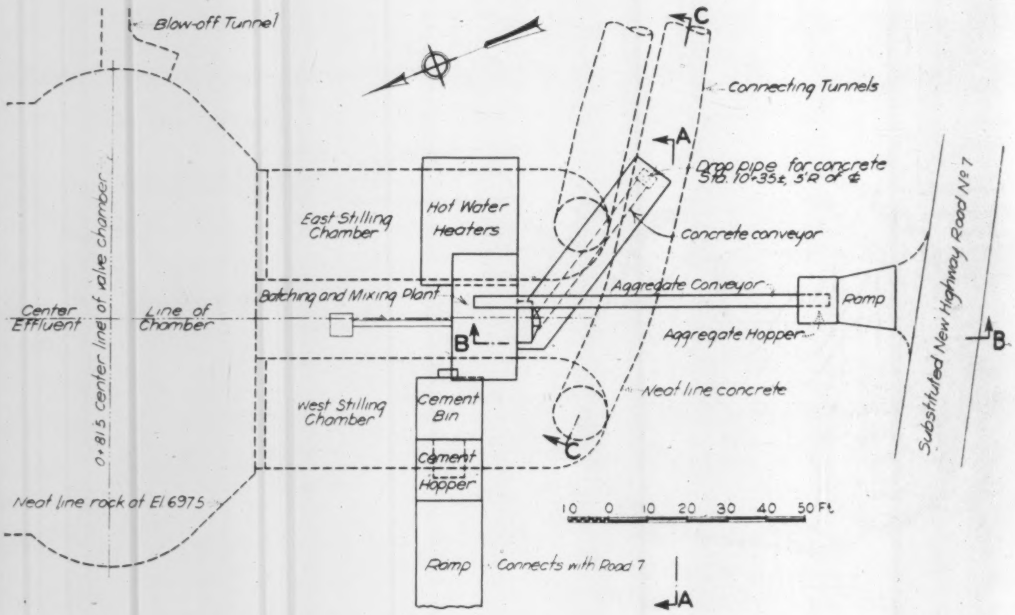


FIG. 3. PLAN OF CONCRETING PLANT AT STILLING CHAMBERS (SECTIONS SHOWN IN FIG. 2)

moved ahead with a utility hoist on the forward end and pins anchored in the rib of the tunnel. A timber platform for the use of finishers at the rear of the forms was controlled by a utility hoist at that end.

The concrete equipment was the same as used for the invert, the discharge line being run along the top of the curb wall with an air booster at the forms. Operations went forward on a 2-shift basis: washing of rock, moving and setting of steel forms and grout pipes were done on the midnight-to-8:00 shift; and setting of the timber bulkhead and concreting were done on the day shift. Average weekly progress was 322 lin ft, with 357 ft as a maximum. An average pour of 59.6 ft involved 202 cu yd and took 7 hours.

As the arch was completed, the rails were reset to the 36-in. gage for grouting and miscellaneous operations. The removal of muck and debris ahead of concreting operations was made through the east stilling chamber, where a wide chute had been constructed.

Inlet Channel to Rondout Effluent Chamber
Batching and Mixing Plant at Top of Cut

This contract also included the Merriman Dam and appurtenant structures. To provide all the aggregate, a processing plant was erected about 1.5 miles upstream from the effluent chamber along the west bank of Rondout Creek, where a large deposit of sand and gravel was found. This plant consisted essentially of a primary and secondary crusher for the over-size stone, a rotary scrubber, four deck vibrating screens grading from $^1/_8$ to $1^1/_2$ in., cones, and a sand classifier. By means of belt conveyors from the processing plant, the product was stored in three stock piles as sand, $^3/_4$-in. stone, and $1^1/_2$ in. stone. Under the stock piles a timber tunnel was constructed housing a belt conveyor fed by four gates under each pile. This conveyor loaded a 3-compartment loading and batching bin. The output of this plant, per shift, was about 180 cu yd of sand and 440 cu yd of coarse aggregate. The aggregate was delivered in bulk to the effluent-chamber batching and mixing plant which had previously been set up at another location for concreting of the caisson and the cutoff wall at the dam. It functioned as follows.

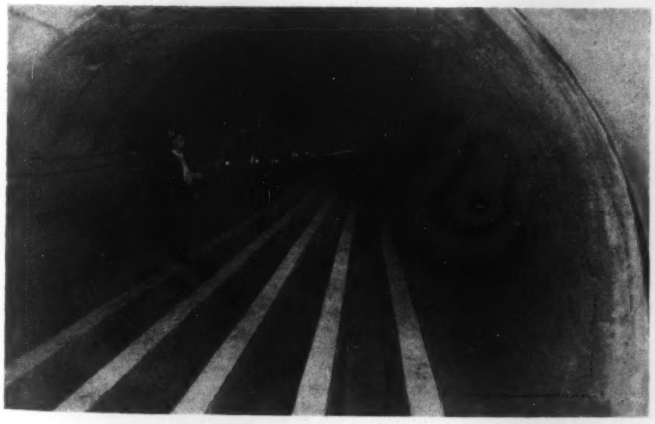
Bulk cement was delivered in enclosed trucks of 40-bbl capacity from the railroad to the receiving hopper of a horizontal screw conveyor, which carried it to a vertical bucket elevator and thence to the 350-bbl working storage bin. When this bin was filled, excess cement went by inclined chute to the 1,000-bbl reserve storage bin. By means of a gate at the bottom of the latter, and the bucket elevator previously mentioned, cement could be transferred as needed to the working bin. Aggregate was delivered by truck to a receiving hopper where a 24-in. belt conveyor carried it to a swivel feed chute at the aggregate compartments, from which it was deposited in the proper bin for sand, $^3/_4$-in. stone, or $1^1/_2$-in. stone.

A cement factor of 2 bbl per cu yd of concrete was used and mixed in the ratio of 1:1.33:2.68 by volume (dry-rodded), with changes to meet the varying conditions of the aggregate. Of the coarse aggregate, 47.5% by weight was less than $^3/_4$ in., and 52.5% between $^3/_4$ and $1^1/_2$ in. The average slump was about 5 in., and required a total of about 5.2 gal of water per bag of cement. An average strength of 6,206 lb per sq in. was indicated by 28-day tests on 9 cylinders. Tubular air vibrators were used to eliminate segregation and provide for the proper distribution of the mass in place. Concrete was mixed in 7-bag or 8-bag batches at the rate of 70 sec per cu yd.

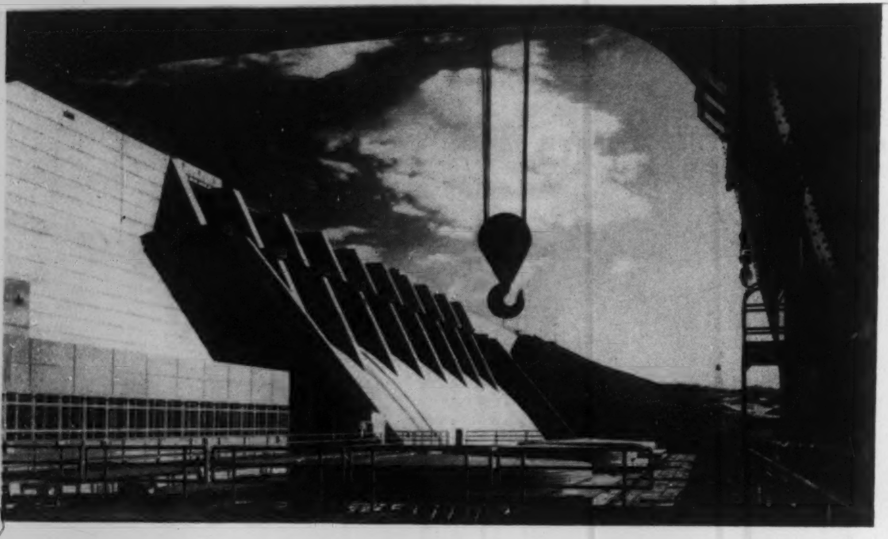
As the concreting of this tunnel was done concurrently with the driving of the tunnel south of Shaft 1, making this shaft unavailable, the contractor had a hole put down from the surface of the rock adjacent to the mixing plant by a churn drill equipped with a 12-in. bit to intersect the center of the tunnel excavation at Sta. 10 + 34.8. The depth drilled was about 130 lin ft and the maximum deviation was 2.25 ft. A 10-in. steel drop pipe was grouted in this hole, and by means of a small belt conveyor concrete was delivered from the mixer receiving hopper to this pipe and thence to the tunnel.

The total time spent in concreting the inclined tunnel, beginning with the mucking of the invert, was 8 months, indicating an over-all average progress of 380 ft of concreted tunnel per month. The construction of this shaft and tunnel was part of a contract which was awarded to the Mason and Hanger Company, Inc. The contractor was represented by Howard L. King as chief engineer, John M. Ribble as job manager, Louis J. Eibsen as resident engineer, and John Ury as superintendent in charge of tunnel concreting.

For the Board of Water Supply, Charles M. Clark was chief engineer; Roger W. Armstrong, deputy chief engineer; James A. Guttridge, department engineer, N. LeRoy Hammond, division engineer; Charles G. Hoerner, senior section engineer; and Herbert A. Dibbell, section engineer. Messrs. King, Armstrong, Guttridge, Hoerner, and Dibbell are members of the Society.



Completed Tunnel with Flume Walls Which Improve Flow Characteristics



Cherokee Spillway and Embankment as Seen from Roof of Power Station

STANDARDIZATION in design of important features of the many units constructed by the Tennessee Valley Authority has effected extensive economies. This discussion of the general plan for the system of power projects is presented by Mr. Rich as an introduction to a series of articles on the TVA. This carefully prepared basic plan makes it possible to coordinate the operation of important units of major projects. This paper by Mr. Rich is the first in a series describing TVA power development.

The Design of Recent TVA Projects

I. A Unified Plan for 34 Major Hydroelectric and Steam Power Plants

By George R. Rich, M. Am. Soc. C.E.

Chief Design Engineer, Tennessee Valley Authority, Knoxville, Tenn.

Under the terms of the basic Act and subsequent legislation to provide power for the wartime emergency, the Tennessee Valley Authority has currently under construction projects which will increase the combined hydroelectric and steam-power capacity of the system to over 2,000,000 kw, afford flood control storage aggregating 15,000,000 acre-ft, and furnish a channel for 9-ft navigation from the mouth of the Tennessee near Paducah to the headwaters at Knoxville, a distance of 650 miles.

The framework of the unified plan consists of the following elements:

1. Main-river projects, comprising a low-head major storage development near the mouth of the Tennessee, for controlling discharges into the Ohio, and a series of low-head projects of limited storage operated strategically to reduce flood crests. These developments provide the 9-ft channel for navigation, the navigation locks and power stations, to develop the 500-ft drop in elevation between Knoxville and Paducah.

2. Main-tributary projects, comprising five medium-head major storage developments, controlling the flow from the five principal headwater tributaries into the Tennessee. These projects afford substantial power generation and are the basic means of regulation for multipurpose operation of the system.

3. Secondary tributary projects, medium-head developments providing holdover storage for the main system and flood protection for the upper valley regions. Owing to the steep slopes of the rivers, these projects furnish economical power generation either directly at the storage dam or by means of a long tunnel.

4. Steam power plants, operating on base load during dry years and for peaking during major floods, when the capacity of the hydro system is limited by the reduction of head.

A summary of the physical features of the hydroelectric plants is given in Table I. The physical features of steam projects are summarized in Table II, and those of major private projects in Table III.

Table I. Summary of Physical Features of Hydroelectric Plants

	Navigation			Reservoir					
Project Name	Miles of 9-Ft Navigation Added	Lock Chamber (Ft)	Max. Lift of Locks (Ft)	Area, Top of Gates (Acres)	Vol., Top of Gate (Acre-Ft)	Controlled Flood Storage (Acre-Ft)	Length of Spillway (Ft)	Spillway Capacity (Cu Ft per Sec)	Backwater Length (Miles)
Kentucky	184.3	110 x 600	73	256,000	6,100,000	4,570,000	960	1,300,000	184.3
Pickwick Landing*	50.0	110 x 600	63	46,800	1,091,400	418,400	880	750,000	52.7
Wilson*	14.6	60 x 300	90	15,500	535,000	43,000	2,212	629,000	15.5
Wheeler*	71.4	60 x 360	53	68,300	1,150,000	429,000	2,400	687,000	74.1
Guntersville*	80.4	60 x 360	45	70,700	1,018,700	282,000	720	625,000	82.1
Hales Bar*	38.7	60 x 267	37	5,760	124,800	......	1,200	600,000	39.9
Chicamauga*	58.2	60 x 360	56	39,400	705,000	377,000	720	600,000	58.9
Watts Bar	63.6	60 x 360	70	41,600	1,132,000	433,000	800	550,000	72.4
Ft. Loudoun	45.4	60 x 360	80	15,500	415,500	138,500	560	380,000	55.0
Norris*	....	......	..	40,200	2,567,000	2,020,000	300	205,000	72.0
Cherokee	....	......	..	31,100	1,565,400	1,413,000	360	254,000	58.5
Douglas	....	......	..	31,600	1,540,000	1,260,000	440	304,000	43.1
Fontana	....	......	..	10,800	1,450,000	1,160,000	330	233,000	29.0
Hiwassee*	....	......	..	6,280	438,000	365,000	224	130,000	22.0
So. Holston	....	......	..	9,100	783,000	644,000	685†	105,000	24.5
Watauga	....	......	..	7,100	677,000	627,000	385†	62,000	16.7
Apalachia	....	......	..	1,093	61,250	36,700	320	150,000	9.8
Chatuge	....	......	..	7,050	243,000	226,500	300	39,000	11.8
Nottely	....	......	..	4,430	189,800	189,200	300	48,000	23.2
Ocoee No. 1*	....	......	..	1,380	76,600	25,800	362	45,000	7.5
Ocoee No. 2*	....	......	..	....	......	......	...	......	....
Ocoee No. 3	....	......	..	518	14,170	9,090	224	100,000	....
Blue Ridge*	....	......	..	3,290	197,500	183,000	110	55,000	10.0
Great Falls*	....	......	..	2,280	54,700	49,600	450	150,000	22.0
Total hydro	606.6			715,781	22,129,820	14,899,790			

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* Project completed except for possible additional generating units.
† Approximate.

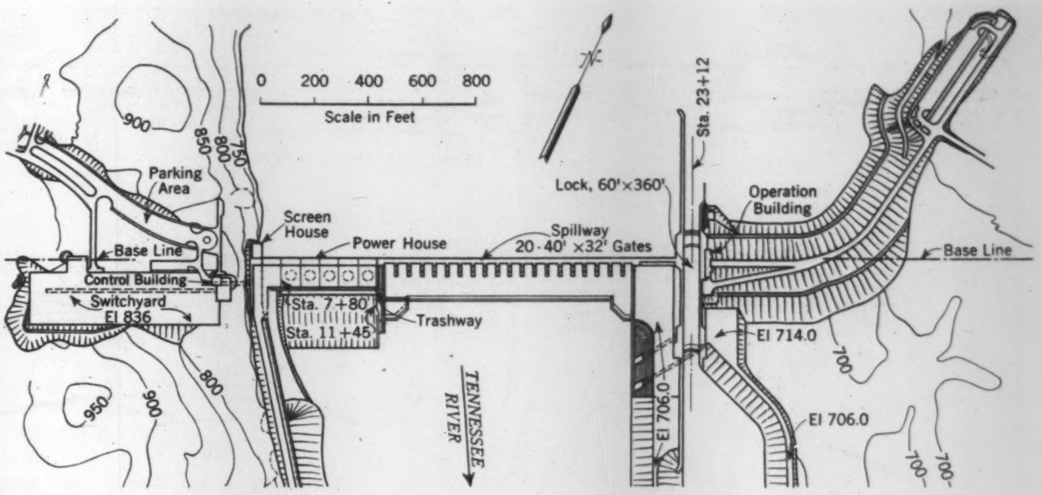


Fig. 1. Diagrammatic Layout of a Typical Low-Head Main-River Project

All engineering and construction work is under the direction of Col. T. B. Parker, M. Am. Soc. C.E., Chief Engineer. Economic feasibility of projects, size of power installations, reservoir levels, spillway capacities, and water control planning are under the supervision of S. M. Woodward, M. Am. Soc. C.E., Chief Water Control Planning Engineer. A. L. Pauls, M. Am. Soc. C.E., is Chief Construction Engineer. The layout and design of structures, gates and accessories, specifications for the purchase of machinery, administration of equipment contracts, and inspection and testing of materials and equipment are under the direction of the author as Chief Design Engineer.

The design organization operates on the pool rather than the project system. Civil, mechanical, electrical, heavy equipment, and architectural divisions are responsible for their respective portions of the design of all projects, as contrasted with the system by which each project has its own staff for all branches of the work.

A compact staff of technical and administrative engineers assist the Chief Design Engineer in operating the Design Department. Acknowledgment is given to Adolph A. Meyer, M. Am. Soc. C.E., Head Civil Design Engineer, and members of the Design Department staff for substantial assistance in the preparation of this paper.

The arrangement of structures for a typical low-head main-river development—Watts Bar—is shown in Fig. 1. The layout represents the most economical adaptation of structures to the geologic, topographic, and hydraulic conditions at the site consistent with the functional requirements of the navigation lock, power station, and spillway.

Power

Rated Head (Ft)	Head for Best Efficiency (Ft)	Plant Capacity, Sept. 1, '42 (Kw)	Ult. Plant Capacity (Kw)	Eff. Capac. During High Flow of '26–'27 (Kw)	Type of Turbines
48	51	.....	160,000	74,000	Kaplan
43	56	144,000	216,000	36,000	Kaplan
95 & 92	95 & 92	284,800	436,000	419,000	Francis
48	48	129,600	259,200	245,000	Propeller
36	37	72,900	97,200	69,000	Kaplan
36 & 35.5	...	51,100	51,100	20,000	Francis
36	48	81,000	108,000	67,000	Kaplan
52	52	90,000	150,000	150,000	Kaplan
65	70	.....	128,000	64,000	Kaplan
165	180	100,800	100,800	100,000	Francis
100	110	60,000	120,000	.....	Francis
100	110	.....	120,000	.....	Francis
330	360	.....	202,500	.....	Francis
190	200	57,600	115,200	115,000	Francis
190	210	.....	75,000	.....	Francis
225	260	.....	60,000	.....	Francis
360	390	.....	75,000	.....	Francis
...	...	.....	.....	.....	....
...	...	.....	.....	.....	....
110	...	18,000	18,000	18,000	Francis
250	...	19,900	19,900	18,000	Francis
280	280	.....	27,000	.....	Francis
147	...	20,000	20,000	20,000	Francis
142 & 105	...	29,370	29,370	29,000	Francis
		1,159,070	2,588,270		

With the exception of the lock for the Kentucky Dam, designed by the Authority, all navigation locks were designed by the U.S. District Engineer at Nashville, and all features pertaining to navigation were established in close collaboration with the Commerce Department of the Authority and the War Department. Particular emphasis is placed upon securing long, straight entrances at each end of a lock. The upper approach must be protected from the spillway overflow area by a long guard wall, and a protective dike is interposed between the spillway channel and the downstream entrance channel to insure undisturbed hydraulic conditions for the traffic which must approach the lower lock gate at greatly reduced speed. Whenever natural conditions permit, this protective dike is preferably constructed simply by extending and riprapping a large natural island.

At low-head developments the power station imposes the highest load concentrations upon the foundation and requires freedom from unequal settlements to insure satisfactory operation of the generating machinery. For these reasons it is preferable to have this structure located on the best foundation rock available at the site. It is also essential that the location selected for the power station afford direct transfer from the station crane to railroad cars and trucks.

In order to keep to a minimum the length of the main generator leads and the multitude of operating cables, the power station and switchyard must be grouped and located as a single unit. Since permanent operation of the navigation lock is the province of the Corps of Engineers, while the operation of the power station is the responsibility of the Authority, it is advantageous to segregate these two component elements of the project to prevent maintenance operations and installation of future equipment in the power station from conflicting with navigation functions. For this reason it is almost invariably the practice of the Authority to locate the power station and switchyard for projects of this type on the opposite bank from the navigation lock, the sole exception being the Kentucky project, where the natural available space between the power house and the lock is of such exceptional size as to permit placing navigation and power functions on the same side of the river without possibility of interference.

The spillway, with its gates and accessories, then occupies a natural position in the center of the river, entirely free from any operating interference with the power and navigation functions. This arrangement is particularly advantageous in enabling the operator to regulate flood

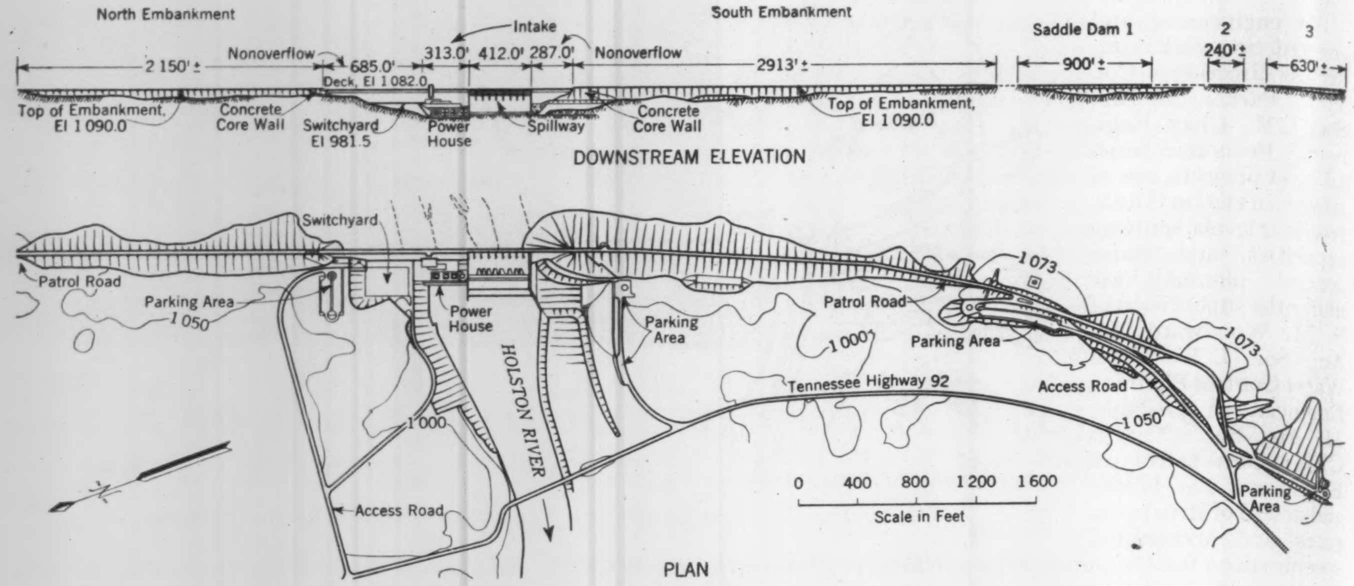

North Embankment
South Embankment
Intake
Nonoverflow
Nonoverflow
2 150' ±
685.0'
313.0'
412.0'
287.0'
2913' ±
Saddle Dam 1
2
3
900' ±
240' ±
630' ±
Deck, El 1 082.0
Top of Embankment, El 1 090.0
Concrete Core Wall
Switchyard El 981.5
Power House
Spillway
Concrete Core Wall
Top of Embankment, El 1 090.0
DOWNSTREAM ELEVATION
Switchyard
Patrol Road
Parking Area
1 050
Power House
HOLSTON RIVER
Parking Area
1 073
Patrol Road
1 000
Parking Area
1 073
Tennessee Highway 92
Access Road
1 050
1 000
Access Road
0
400
800
1 200
1 600
Scale in Feet
Parking Area
PLAN

FIG. 2. DIAGRAMMATIC LAYOUT OF A TYPICAL MAJOR TRIBUTARY STORAGE DEVELOPMENT

discharge so as to distribute the effects of any possible erosion uniformly over the river bed below the spillway apron. It frequently happens on the Tennessee River that this central portion of the channel affords rock foundations at comparatively high elevations to permit economical construction of the spillway and apron.

MAIN TRIBUTARY PROJECTS

Arrangement of structures for a typical major tributary storage development—Cherokee—is shown in Fig. 2. In contrast with the main-river projects, in which the lock, power station, and spillway have about equal weight in establishing the basic layout, the general plan for a major storage development is dominated by the necessity of fitting the dam to the topography and geology of the site so as to obtain the least expensive structure consistent with maintaining a straight alinement of channel to accommodate the relatively high-velocity discharge below the spillway apron.

Just as in the case of the low-head main-river plants, the power station and switchyard must be considered as a unit in order to obtain economy in generator leads and control cables. Other factors being equal, these two elements will be located so as to be most readily accessible from existing highways and railroads, with due attention to the direction of transmission lines.

With but one exception, all five major tributary storage developments permit location of the power house and switchyard adjacent to the spillway apron at the foot of the dam. At the Fontana Project, however, the canyon is too narrow to permit such an arrangement. This consideration, together with other factors associated with the high head, require departures from the typical design for main tributaries, particularly in connection with stresses due to temperature changes, both from seasonal variations and from the chemical heat of setting. This difficulty is accentuated by the wartime requirement that the project construction be completed in 24 months, which means pouring a total of 2,660,000 cu yd at a peak rate which may reach 250,000 yd per month. The governing principle of design was, therefore, to make the dam section a simple rugged monolith as free as possible from openings such as discharge outlets and elevator shafts, and entirely divorced from all river diversion problems. Following this principle it was possible to construct the dam in a single stage, with uniform pouring progress over the entire area.

This objective was accomplished with greatest economy by providing two large tunnels in the side hill to pass the spillway discharge. By constructing low-level branches to these tunnels, they could be used for river diversion during construction. This arrangement affords the greatest flexibility in the design of the construction bridge and concreting plant because it eliminates details which interfere with the location of the construction bridge columns. The accelerated tempo of concreting can proceed uniformly, and except in the vicinity of the three power conduits, there is no necessity for special time-consuming local treatment to inhibit shrinkage and setting stresses. The adopted arrangement permits placing the power station directly in the natural river channel at the foot of the dam.

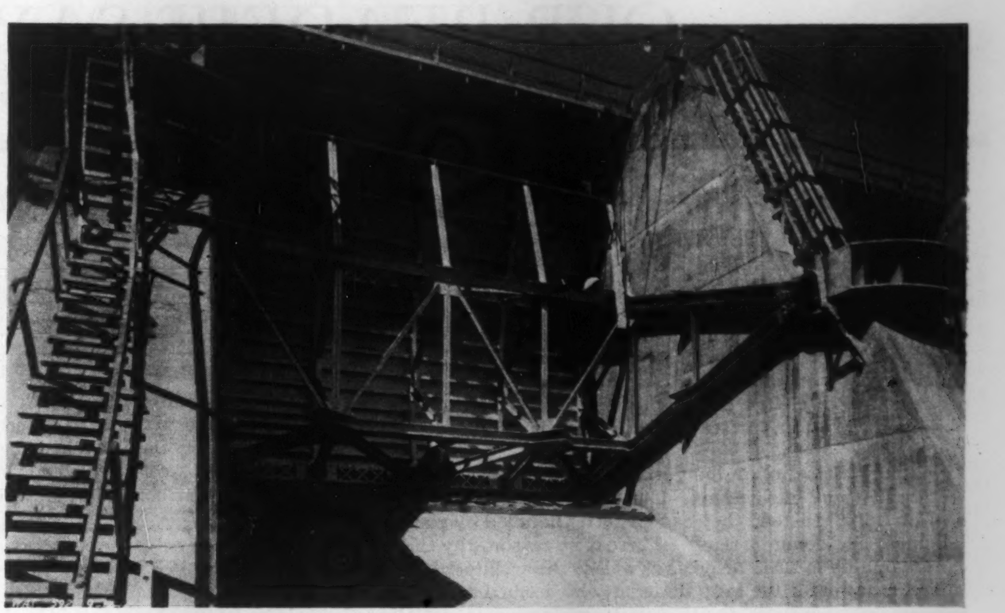
TABLE II. SUMMARY OF PHYSICAL FEATURES OF STEAM PROJECTS

PROJECT NAME	PLANT CAPACITY, SEPT. 1, '42 (KW)	ULT. PLANT CAPACITY (KW)
Nashville*	48,000	48,000
Watts Bar*	40,000	40,000
Parksville*	13,000	13,000
Hales Bar	120,000	240,000
Wilson*	60,000	100,000
Memphis*	54,000	54,000
Columbus*	770	770
Corinth*	1,800	1.800
Tupelo*	3,500	3,500
Nitrate Pl. No. 1*	5,000	5,000
Total steam	346,070	506,070
Total TVA system	1,505,140	3,094,340

* Project completed except for possible additional generating units.

SECONDARY TRIBUTARY PROJECTS

The Apalachia Project is a typical example of power development on a tributary river having steep slopes and located downstream from a major storage development, Hiwassee. The structural arrangement consists essentially of a standard gravity overflow spillway connected to the power station by means of an eight-mile concrete-lined tunnel, so as to afford the maximum head that can be justified economically. The power station is a simple rugged concrete structure of conventional design, so located as to permit excavating the relatively large surge tank entirely in sound natural rock.



Standard Design of 32 by 40-Ft Tainter Gate Used Without Change on Several Projects

The impounding structures for the South Holston and Watauga projects are rolled-fill embankments with substantial rock-fill supporting shells. It was found economical on these developments to use tunnels for the combined purpose of spillway service and diversion during construction. Separate tunnels are provided for power generation.

The basic design of hydraulic structures is strongly influenced by the geology of the region in which they are constructed. The characteristic formation of nearly all but the highest portions of the Tennessee Valley region is limestone, a rock of relatively high solubility when geologic periods are considered, and one which, generally speaking, requires extensive subsurface treatment and grouting of natural solution channels to inhibit penetration of water under the dam. A few projects located at higher elevations in the extreme eastern portions of the region, in the foothills of the Great Smoky Mountains, are more favorably situated in territory where the predominating formations consist of metamorphosed sedimentary rocks such as graywacke and quartzite. These formations provide an effective barrier to the entrance of water under the dam and require a comparative minimum of grouting and foundation treatment.

GRAVITY STRUCTURES SELECTED

After economic analysis of several competing types of concrete dam, gravity structures without exception have been selected as best meeting the local requirements. They are so proportioned that under the maximum possible head no tensile stresses from cantilever action occur over any portion of the section. Whenever an effective foundation drainage system can be installed, the resultant relief from hydrostatic pressure is reflected in the uplift assumptions. For the low-head main-river dams, the uplift intensity is customarily varied from headwater pressure at the upstream face to tailwater pressure at the drains, and tailwater pressure over the remainder. For the higher storage dams on the tributaries, this assumption is modified by assuming full headwater pressure at the upstream face, diminishing to 50% of headwater pressure at the drains, and thence to tailwater pressure at the toe. In all cases uplift is assumed to act over only two-thirds of the base area.

Maximum allowable compressive stresses and shear-friction values are established after a careful review of the geological and mineralogical investigations at the individual site. In certain instances the shearing strength of the foundation material has been found to be as low as 11 lb per sq in. for weak shale, while at other sites the rock is far stronger than the concrete, making the concrete strength (assumed as 600 lb per sq in.) the limiting consideration. For the average shear at the base, a factor of safety of 4 is provided over the shear-friction strength as established by tests.

Where the modulus of elasticity of the foundation rock is very low, or where the dam is superimposed upon different rock formations having widely varying elastic characteristics, special seals are provided in the transverse joints between blocks to allow for unequal settlement.

In the case of the low-head main-river plants, the power station is part of the main dam across the river, and the distinctive feature of this structure is the utilization of the combined mass of both intake structure and turbine foundations to sustain the hydrostatic load from the reservoir. In general, this results in a cellular structure of great ruggedness and economy, liberally reinforced not only for the easily calculated hydrostatic loads immediately adjacent to the waterways, but also to furnish a generous margin of strength to meet the relatively intangible stresses resulting from temperature changes. For exceptional flood conditions and temporary construction loadings, an increase of 25% over normal structural stresses is permitted.

Table III. Summary of Physical Features of Major Private Projects (Hydro)

	Reservoir						Power			
Project Name	Area, Top of Gates (Acres)	Vol., Top of Gate (Acre-Ft)	Controlled Flood Storage (Acre-Ft)	Length of Spillway (Ft)	Spillway Capacity (Cu Ft / Sec)	Backwater Length (Miles)	Rated Head (Ft)	Plant Capacity Sept. 1, '42 (Kw)	Ult. Plant Capacity (Kw)	Type of Turbines
Cheoah*	620	31,000	7,500	450	200,000	7.0	180	76,000	76,000	Francis
Calderwood*	500	34,000	3,750	600	260,000	8.0	213	121,500	121,500	Francis
Santeetlah*	2,850	156,000	131,000	150	92,000	..	660	45,000	45,000	Francis
Nantahala*	1,420	.....	124,000	...	....	3.5	925	43,200	43,200	Francis
Glenville*	1,470	71,000	68,000	...	....	4.5	1,150	21,600	21,600	Double Pelton Wheel
Waterville*	340	25,000	20,500	336	60,000	5.5	755	108,000	108,000	Francis
Total private projects	7,200	317,000	354,750					415,300	415,300	
Total for Tennessee Valley	722,981	22,446,820	15,254,540					1,920,440	3,509,640	

* Project completed except for possible additional generating units.

OUR READERS SAY—

In comment on Papers, Society Affairs, and Related Professional Interests

Responsibility for Buildings

To the Editor: The article by Mr. Pickworth in the October number, entitled "Building Design as an Art," has my approval with one exception. Mr. Pickworth feels that the architect should be the coordinator on building construction; it is my belief that in many buildings, particularly of the industrial type, engineers are more competent to be the master mind than the architects. This belief is based on many years as chief engineer for a large mail-order house, in charge of design and construction of commercial buildings. Most important of these were the mail-order operating plants.

So many phases of an industrial building are neither pure architecture nor pure engineering. Thus they fail to meet either qualification fully. Instead they can be better handled by good business judgment and common sense. There is no reason why the engineer cannot qualify in these respects as well as the architect.

The example of the lady designer who seemed surprised that a layman knew so little about engineering design is not altogether the exception. The same is true even with men of rather broad experience. For example, I had an experience with the president of one of the largest mail-order companies in America. Following a business trip, I had explained to him that the building department of a West Coast city had finally agreed to accept a design in accordance with Chicago building code regulations rather than following their own code, which was not particularly up to date. This had allowed us to save over $15,000 in the column design alone. The president, pointing to a column in his office, said: "Do you mean a column like that?" And when I said I did, he said, "I always thought a column was a column."

W. H. McCaully, Assoc. M. Am. Soc. C.E.
Engineering Systems, Inc.

Chicago, Ill.

Reinforced Columns Under New Code

Dear Sir: In connection with Mr. Albert's article on "Economy Method of Computing Steel for Reinforced Concrete Columns," in the February issue, I would like to point out that certain details of this article are not in accord with the new code (War Production Board National Emergency Specifications for the Design of Reinforced Concrete Buildings, dated November 10, 1942).

Any column in which bending exceeds the direct stress can be classified as a flexural member, and the code states on Page 9, Article 306*b*, that "The effectiveness of compression reinforcement in resisting bending may be taken at twice the value indicated from the calculations, assuming a straight line relation between stress and strain, but not greater value than the allowable stress in tension."

Then Mr. Albert's Eq. 3*a* will be

$$f_s' = 2(n-1)\frac{x-d'}{x} = 2(n-1)f_c\frac{k-d/d'}{k}$$

Equations 6 and 7 remain the same.

Using his own Example 1, a column 12 by 22 in. (Fig. 2) takes an eccentric load. If the stress is fixed as $f_s = 20{,}000$ lb per sq in., and $f_c = 650$ lb per sq in., $n = 15$, $d' = 2$ in. Using Eq. 1, $K = 0.228$, $x = 0.328 \times 20 = 6.55$ in.

Now using Eq. 3*a*, we will get an allowable steel stress in compression.

$$f_s' = 2(15-1) \times 650\,\frac{6.55-2}{6.55} = 9{,}850 \text{ lb per sq in.,}$$

and moments with reference to A_s' and A_s will be as before:

$M_s' = 12{,}700(53.9-9.0) = 571{,}000$ in.-lb; $M_s = 12{,}700(53.9 + 9.0) = 800{,}000$ in.-lb.

Hence the steel areas become by use of Eqs. 6 and 7

$$A_s = \frac{571{,}000 + {}^1/_2 \times 650 \times 12 \times 6.55\left(\frac{6.55}{3} - 2\right)}{20{,}000\ (20-2)} = 1.599 \text{ sq in.}$$

$$A_s' = \frac{800{,}000 - {}^1/_2 \times 650 \times 12 \times 6.55\left(20 - \frac{6.55}{3}\right)}{9{,}850\ (20-2)} = 1.95 \text{ sq in.}$$

The result shows that it is more economical to follow the new code. To make Mr. Albert's article practicable it must be adjusted for the present emergency condition. By lowering the tensional steel stress, even more economy will result, which fact is of course commonly known.

New York, N.Y.

A. L. Pavlo, Assoc. M. Am. Soc. C.E.
Senior Structural Engineer,
John V. D. Reynders

Forum on Professional Relations

Conducted Column of Hypothetical Questions with Answers by Dr. Mead

For some months past Dr. Mead has been answering questions on engineering ethics in these columns. In the current issue he gives his answer to Question No. 6, which was announced in the January issue. This question states that, "A young engineer employed by an engineering firm has had extensive experience in virtual charge of a large piece of important work that was being done for one of the firm's clients. Recognizing the fact that he would be of considerable value to the client because of his detailed knowledge of the work under construction, he applied for a position which finally was offered him at a higher salary than that which he was receiving from the engineering firm. Is he justified in applying for and accepting such a position?"

Most ethical questions need further explanation before they can receive definite answers. A young engineer when securing employment is usually engaged on the basis of some definite arrangement as to time of service or with an understanding that he will receive or give specific notice before being dismissed or before leaving his job. Both employer and employee should observe such agreement before a change in employment is made. If the requirement for due notice is observed, there should be no question, usually, as to the right of the employee accepting a new position.

In this particular case, however, the employee should be careful not to so act that he can be accused of infringing on Article 3 of the Society's legal code of ethics. This reads: "It shall be considered unprofessional to attempt to supplant another engineer after definite steps have been taken toward his employment."

In other words, if this young engineer's employment means that he is to take the place of his former employer in finishing the work for which his former employer has been retained, such acceptance should be considered definitely unethical. If, however, he is employed for purposes that do not interfere directly with his former employer's relations with his client, his acceptance should be considered strictly ethical.

Madison, Wis.

D. W. Mead, Past-President and Honorary
Member Am. Soc. C.E.

Other problems of professional relations will be treated by Dr. Mead each month. Next in sequence, for study and written discussion by members until March 5, with answers in the May issue, will be the following:

Question No. 8: *An engineer who had purchased a number of shares of stock in a local public service company was asked by the directors of the company to make a report on a project which they had under consideration. The directors of the company were ignorant of the fact that the engineer owned stock in the company. Should the engineer accept the job?*

SOCIETY AFFAIRS

Official and Semi-Official

Texas Section Invites the Society to Its April Meeting

THE NEAREST thing to a Spring Meeting of the Society in 1943 will be the semi-annual meeting of the Texas Section, to be held in Dallas during the week of April 5. A semi-official tinge to this affair will be given by the presence of Society officers and the Board of Direction, who will be holding their regular sessions. All other members of the Society, too, are cordially invited by the Texas Section to join with them.

Any of those who have previously had such a pleasure, for example, at the San Antonio Meeting in 1937, will need no second invitation. No more cordial and earnest group than the Texas members is to be found in the Society. They always have a good time and a worth-while meeting, and no member should hesitate for fear of not being made welcome and amply repaid.

Because of the railroad transportation situation, the normal schedule has been somewhat rearranged, to utilize much of the week starting Monday, April 5. That day, committees of the Board and of the Society will gather. Tuesday, the sixth, will be devoted to Board sessions and Wednesday morning, the seventh, to a Local Sections Conference. Then Wednesday afternoon and all day Thursday will be given over to the technical program of the Texas Section. Events characterized by the well-known Texas hospitality will be scheduled for Wednesday and Thursday evenings.

All the details of the meeting are subject, of course, to final revision. However, it is certain that the time schedule will hold. Headquarters will be at the Baker Hotel in Dallas. For last-minute details consult the final notice to appear in the April issue.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

ON JANUARY 18–19, 1943, the outgoing Board of Direction met at Society Headquarters with the following members present: President E. B. Black in the chair; George T. Seabury, Secretary; Past-Presidents Hogan and Fowler; Vice-Presidents Burdick, Stevens, Spofford, and Stanton; and Directors Blair, Boughton, Burpee, Carey, Cowper, Cunningham, Dickinson, Dunnells, Goodrich, Howard, Hyde, Lilly, McNew, Massey, Polk, Rawn, Requardt, White, and Wiley; and Treasurer Trout. The attendance of the Board was 100%.

In addition, by invitation, a number of the members of the incoming Board were present during part or all of the sessions as observers, including Messrs. E. B. Whitman, E. M. Hastings, T. R. Agg, R. E. Bakenhus, C. B. Breed, N. W. Dougherty, Dean G. Edwards, C. F. Goodrich, and Fred C. Scobey.

Minutes Approved

Minutes of the meeting of the Board of Direction on October 12, 1942, were approved; likewise the minutes of the Executive Committee held on October 11, 1942. The minutes of the Executive Committee for December 13, 1942, also were approved as written and the actions outlined therein, except with respect to certain recommendations acted upon separately, were adopted as actions of the Board.

Meetings for 1943

Following canvass of all possibilities and full discussion, it was decided that the 1943 Convention be held on or near the West Coast; and that the regular Spring and Fall Meetings of the Society be omitted. Instead of such Spring and Fall Meetings, the Board decided to meet for its Spring session at Dallas, Tex., in conjunction with the regular semi-annual meeting of the Texas Section; and to hold its Fall session at Atlanta, Ga., in collaboration with the Georgia Section. Further details of these plans are given in another item in this issue.

Student Chapters, Including Notre Dame

Full report was received from the Committee on Student Chapters, detailing the activities of this group over the year, many of which have previously been recorded in CIVIL ENGINEERING. Upon recommendation of the Committee, the Board approved the establishment of a Chapter at the University of Notre Dame, formerly represented by the Civil Engineers Club of the University.

Engineering Education

After full discussion, the Board adopted the recommendations of its Committee on Engineering Education comprising resolutions under the heading, "Emergency Conditions in Engineering Education," and "Long-Range Problems and Objectives of Engineering Education." Details of this resolution under the corresponding headings "A" and "B" are given elsewhere in this issue as a separate item.

Division Activities

A report of the work of the Society's Technical Divisions during 1942 was presented by the Committee on Division Activities; excerpts are given in an item elsewhere in this issue.

The Committee further offered a resolution providing greater interdependence between the Board and the several Technical Divisions, which resolution was adopted in the following form:

> "RESOLVED: that it shall be the policy of the Board (*a*) before making appointment to a committee charged with technical engineering matters to seek the advice of the appropriate Division chairman, and (*b*) before taking action on any committee report involving matters of technical engineering, to seek the advice of the appropriate Division executive committee."

Relations with the Government

Report was received from the Society's representative in Washington on matters developing there as they may affect engineers, including consideration of the bill proposing the establishment of an "Office of Technological Mobilization."

Engineer Employer-Employee Relations

Report was received from the Committee on Employment Conditions and the staff member assigned to those problems, it being decided that an effort should be made to secure an authoritative clarification of the Fair Labor Standards Act as related to both engineer-employers and employers, on defense and war work.

Employment Recommendations

Resolutions adopted by the District of Columbia Local Section calling for continued study of the classification and salary problems of civil engineers, and proposing the formulation of a procedure capable of use as a collective bargaining agency, were received and thoroughly discussed, but without adoption of the actions as specifically recommended.

Local Sections Allotment

Upon recommendation of the Committee on Local Sections, following full discussion of financial relations, the Board voted to continue the financial support of Local Sections during 1943 on the same basis as 1942, but permitting some relaxation in the requirements for number of meetings.

Unemployment of Civil Engineers

A report was received dealing with "Prospective Unemployment of Civil Engineers," an abstract of which is given in a separate item in this issue.

Membership Activities

The Committee on Membership Qualifications brought a number of cases to the Board for decision; it also offered its annual report commenting upon the more than 1,900 applications for admission and transfer which it had reviewed.

A Timely Reminder

Now is the time to remember that dues paid to the Society are a proper deduction from taxable income in computing your federal income tax. The same is true of the purchase of technical journals and books as well as of similar professional expenses.

In the old 4% tax days a twenty-dollar deduction on the tax return was reflected in a reduction of about seventy cents in the tax payable. Under the much higher prevailing rates, on a taxable income of $1,500, the reduction is about four dollars. The saving is proportionately larger on higher incomes—it is more than five dollars on a $4,500 taxable income.

What this amounts to, therefore, is that by taking advantage of this allowable deduction, the effective cost of Society membership is considerably reduced—by upwards of 20% as a matter of fact. This saving is of more than academic interest in these times of ever-rising costs of living.

Provision for Reinstatement

In order to expedite the readmission of former members of the Society, the following method was approved and adopted:

> "*Procedure for Reinstatement.*—Applicants for readmission to the Society, in the same grade as held formerly, but who have been separated from the Society for more than one year, will be asked to submit a professional record covering the interim period and to name three Corporate Members who have knowledge of what they have been doing since the date of separation from the Society. Reports will be requested from the Corporate Members named and from that Local Membership Committee which seems likely to have the most knowledge of the applicant. Interview by the local Membership Committee will not be required, but expression of opinion of suitability will be requested as from personal knowledge or by inquiry. The information received from three Corporate Members and the Local Membership Committee will be sent to the members of the Membership Qualifications Committee. If four favorable replies from members of the Membership Qualifications Committee are received, and no unfavorable reply is received, the applicant will be considered readmitted and will be so notified."

Greetings from Argentine Engineers

Receipt of a radiogram was reported, expressing the good wishes of the new year from the Centro Argentino Ingenieros. These good wishes were received with appreciation, and with provision for a suitable reply.

World Power Conference

Responding to a request from the World Power Conference, a standing resolution was adopted, making the president of the Society, concurrent with the presidents of other societies, an ex officio member of the Executive Committee of the World Power Conference.

War Specifications—Steel for Buildings

Confirming recommendations from the Society's Structural Division, the Board approved a document entitled "War Production Board National Emergency Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" for use during the present emergency. (See item in the January 1943 CIVIL ENGINEERING, page 63.)

Standards on Letter Symbols

A standard was presented from the American Standards Association covering "Standard Letter Symbols for Heat and Thermodynamics Including Heat Flow." On recommendation of the Society's representatives to American Standards Association, approval was given to these letter symbols.

Standards for Testing Bitumen

Similarly, on recommendation of the officials of the Highway Division, the Board approved the new "Standard Method of Test for the Determination of Bitumen," developed under the American Standards Association and the American Society for Testing Materials.

Districts and Zones

Upon report of the Committee on Districts and Zones it was voted to continue the boundaries of Districts and Zones for the year 1943, as in 1942.

Other Committees

Annual and progress reports were received from various Board committees. Among these may be mentioned the Committees on Professional Conduct, Securities, Juniors, Registration of Engineers, Professional Objectives, Salaries, Employment Conditions, and Publications.

Budget

Items of prospective Society income and expenditure were canvassed and discussed in detail. As a result, details of the proposed budget for 1943 were determined for transmission to the incoming Board with recommendation for adoption.

Other Actions

A variety of other matters were presented. These were received for information or for appropriate action as required.

Adjournment

The 1942 Board of Direction adjourned to meet in its new 1943 membership, as an incoming Board on January 21.

Meeting of the Incoming Board of Direction—Secretary's Abstract

THE incoming Board of Direction met at Society Headquarters on January 21, 1943, with President Ezra B. Whitman in the chair; and present George T. Seabury, Secretary; Past-Presidents Fowler and Black; Vice-Presidents Spofford, Stanton, Hastings, and Agg; and Directors Bakenhus, Boughton, Breed, Burpee, Carey, Cowper, Cunningham, Dickinson, Dougherty, Edwards, Goodrich, Howard, Lilly, McNew, Massey, Rawn, Scobey, and Wiley.

Budget for 1943

Items of the budget for 1943, as recommended by the outgoing Board, were taken up in detail, and after discussion some revisions were made. This budget was then adopted officially.

Sewerage Section in Bureau of Government Requirements

Information was received from the Executive Committee of the Sanitary Engineering Division, and as a result the Board adopted a resolution requesting that the War Production Board include a Sewerage Section in its Bureau of Government Requirements, with proper engineering personnel. This resolution is given in another item in this issue.

Committee Appointments

On recommendation of the President, the Board approved the selection of committee personnel as follows, and the President was given authority to make any further necessary adjustments:

EXECUTIVE COMMITTEE: Ezra B. Whitman, *Chairman;* George W. Burpee, *Vice-Chairman;* E. B. Black, Frederick H. Fowler, E. M. Hastings, and Charles M. Spofford.

COMMITTEE ON HONORARY MEMBERSHIP: Ezra B. Whitman, *Chairman;* T. R. Agg, E. B. Black, Frederick H. Fowler, E. M. Hastings, Charles M. Spofford, and T. E. Stanton, Jr.

COMMITTEE ON PUBLICATIONS: R. B. Wiley, *Chairman;* N. W. Dougherty, E. E. Howard, Scott B. Lilly, and, Fred C. Scobey.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: J. W. Cunningham, *Chairman;* V. T. Boughton, Charles B. Breed, W. D. Dickinson, Dean G. Edwards, and George B. Massey.

COMMITTEE ON PROFESSIONAL CONDUCT: Charles M. Spofford, *Chairman;* V. T. Boughton, Wm. N. Carey, C. F. Goodrich, A. M. Rawn, and G. J. Requardt.

COMMITTEE ON DISTRICTS AND ZONES: E. E. Howard, *Chairman;* John W. Cowper, J. T. L. McNew, George B. Massey, and, A. M. Rawn.

1943 Board of Direction of the Society

Starting at near corner of table and proceeding clockwise: George W. Burpee, Director, District 1; A. M. Rawn, Director, District 11; John W. Cunningham, Director, District 12; Frederick H. Fowler, Past-President; Thomas E. Stanton, Vice-President, Zone IV; Charles F. Goodrich, Director, District 6; Charles B. Breed, Director, District 2; Scott B. Lilly, Director, District 4; Fred C. Scobey, Director, District 13; Dean G. Edwards, Director, District 1; R. E. Bakenhus, Director, District 1; George B. Massey, Director, District 8; Col. William N. Carey, Director, District 7; T. R. Agg, Vice-President, Zone III; E. B. Black, Past-President; Ralph B. Wiley, Director, District 9; N. W. Dougherty, Director, District 10; V. T. Boughton, Director, District 1; Edgar M. Hastings, Vice-President, Zone II; Carolina Crook, Secretary to Mr. Seabury; George T. Seabury, Secretary; Ezra B. Whitman, President; William D. Dickinson, Director, District 14; J. T. L. McNew, Director, District 15; Charles M. Spofford, Vice-President, Zone I.

Committee on Division Activities: Charles M. Spofford, *Chairman;* Wm. N. Carey, J. W. Cunningham, E. M. Hastings, and, R. B. Wiley.

Committee on Society Relations: Ezra B. Whitman, *Chairman;* G. W. Burpee, E. P. Goodrich, and J. P. Hogan.

Meeting Committees:

Annual Meeting: Charles M. Spofford, *Chairman;* R. E. Bakenhus, V. T. Boughton, G. W. Burpee, and Dean G. Edwards.

Annual (Summer) Convention: Thomas E. Stanton, *Chairman;* J. W. Cunningham, J. T. L. McNew, A. M. Rawn, and Fred C. Scobey.

Committee on Professional Objectives: T. R. Agg, *Chairman*, term ending January 1945; Paul L. Brockway, term ending January 1944; N. E. Lant, term ending January 1944; G. J. Requardt, term ending January 1944; Glenn L. Parker, term ending January 1945; and A. M. Rawn, term ending January 1945.

Committee on Local Sections: J. A. Higgs, *Chairman*, term ending January 1944; F. H. Kingsbury, term ending January 1945; F. H. Rhodes, term ending January 1946; Lloyd D. Knapp, term ending January 1947; and J. T. L. McNew, *Contact Member.*

Committee on Juniors: Frank V. Ragsdale, *Chairman*, term ending January 1944; Charles A. Mockmore, term ending January 1945; John H. Gardiner, term ending January 1946; Dana E. Kepner, term ending January 1947; and Wm. D. Dickinson, *Contact Member.*

Committee on Student Chapters: Clarence L. Eckel, *Chairman*, term ending January 1944; Frank W. Stubbs, Jr., term ending January 1945; Ben S. Morrow, term ending January 1946; Paul Weir, term ending January 1947; and Scott B. Lilly, *Contact Member.*

Committee on Engineering Education: James A. Anderson, *Chairman*, term ending January 1944; William E. Baldry, term ending January 1945; Ivan C. Crawford, term ending January 1946; Conde B. McCullough, term ending January 1946; and Ralph B. Wiley, *Contact Member.*

Committee on Fees: Louis R. Howson, *Chairman*, term ending January 1944; Edward N. Noyes, term ending January 1945; Clarence McDonough, term ending January 1946; L. H. Nishkian, term ending January 1947; and George W. Burpee, *Contact Member.*

Committee on Registration of Engineers: T. Keith Legaré, *Chairman*, term ending January 1944; H. M. Jones, term ending January 1945; Robert H. Craig, term ending January 1946; Harold G. Sours, term ending January 1947; and, N. W. Dougherty, *Contact Member.*

Committee on Salaries: Thomas E. Stanton, *Chairman and Contact Member;* Charles D. Avery, Arthur Richards, Andrew P. Rollins, and Charles S. Shaughnessy.

Committee on Employment Conditions: A. M. Rawn, *Chairman and Contact Member;* Ashley G. Classen, L. Murray Grant, Gail A. Hathaway, and C. W. Okey.

Committee on Technical Procedure: Charles M. Spofford, *Chairman;* William N. Carey, J. W. Cunningham, E. M. Hastings, and R. B. Wiley (all members of the Committee on Division Activities); and John Nolen, Jr., *Chairman*, City Planning Division; Harry O. Locher, *Chairman*, Construction Division; E. D. Gilman, *Chairman*, Engineering Economics Division; R. L. Morrison, *Chairman*, Highway Division; Boris A. Bakhmeteff, *Chairman*, Hydraulics Division; E. B. Debler, *Chairman*, Irrigation Division; Herbert J. Flagg, *Chairman*, Power Division; A. Clinton Decker, *Chairman*, Sanitary Engineering Division; Joel D. Justin, *Chairman*, Soil Mechanics and Foundations Division; Glenn B. Woodruff, *Chairman*, Structural Division; William N. Brown, *Chairman*, Surveying and Mapping Division; and W. G. Atwood, *Chairman*, Waterways Division.

Adjournment

The Board adjourned to meet in April at Dallas, Tex.

Appointment of Society Representatives

Harrison W. Craver, director of the Engineering Societies Library, has been reappointed to represent the Society on the American Documentation Institute for the three-year term beginning January 1943.

Reduced Employment of Civil Engineers Foreseen

In view of the frantic efforts of civil engineers to keep up with the national demand for their work, it is inevitable that a slowing up must take place sooner or later. The date and the extent may be problematical, but the fact itself seems to the Board of Direction unavoidable. Hence it appointed a committee "to study prospective unemployment of civil engineers." A condensation of the report of that committee, as submitted at the January meeting of the Board, follows.

Two things seem clear: first, that the defense or war construction program reached its peak, both in volume of construction and in number of engineers employed, during August 1942; and second, that the program will be nearly over so far as employment of engineers is concerned early in 1943.

The date of the peak is a matter of record, and several studies point to a practical cessation of general demand for civil engineers on war project design and construction at a relatively early date. Among these indications may be cited the following:

A comprehensive forecast of the decrease in war construction is given in the general statement released by the Secretary of Labor, under date of December 17, 1942. That statement shows that during the peak month of war construction, August 1942, there were 1,675,000 persons employed in publicly financed construction. The report estimates that by June 1943 such employment will be reduced to 810,000, or 48.5% of the peak, and that later in the year the number will fall to 400,000, or only 24% of the 1942 maximum. These figures cover employment of all classes, but so far as engineers are concerned the rapid downward trend is confirmed by the following data for two large construction agencies whose great programs have afforded extensive engineering work.

First, of the 1,600 projects comprising the nine billion dollar program of the Reconstruction Finance Corporation (Defense Plants Corporation) 900 have gone into partial or complete operation by January 1, 1943; the civil engineering required in the completion of its program will largely be confined to supervision of construction.

Second, it has been publicly stated that the War Department program of about eight billion dollars in 1942 will drop to about one billion dollars in 1943; here again the 1943 expenditures will represent unfinished construction requiring only routine supervision rather than new projects requiring surveys, design, plans, and specifications.

The statements cited above, particularly the summary by the Secretary of Labor, concerning general construction employment on war projects, point to a reduction of 50% of the 1942 peak by June 1943. That engineering employment will drop more rapidly is noted above, and has been confirmed by the records of one of the larger construction agencies; these show that from August to December 1942 the personnel of engineering organizations employed in its operations had been reduced about 50%. A continuation of that rapid decrease may be anticipated, in the opinion of the Committee, until March or April 1943, by which time most of the engineering on the preceding programs will have been completed.

Some measure of the effect of this reduction on the employment of our members may be had from the postcard questionnaire regarding their wartime activities circulated by the Society during the peak war construction, August 1942. Returns were received from an exceptionally large percentage of those circularized, and have been published in CIVIL ENGINEERING (Vol. 12 (1942), No. 9, page 529, and No. 10, page 581). Of approximately 17,700 cards sent out, nearly 12,900 were returned. These showed that 45.6%, or about 5,880 of our members were then engaged on "War Projects or Industries." A forecast of the employment of these members would be far more dependable had the 5,880 been segregated into "War Projects" and "War Industries," since unless further construction programs, not now anticipated, develop at an early date, most of those employed on "War Projects" will be seeking employment in other fields, among which that of "War Industries" seems to afford the best prospects. In any event, a 70% drop in the employment of the 5,880 would leave over 4,000 of our members seeking relocation and an 85% drop would similarly affect 5,000.

A statement of age was not included in the questionnaire, and it is therefore not certain that the data collected in the Register of Professional and Scientific Personnel are applicable. An unpublished report based on that register shows that a total of 87,600 persons in this country claim to be Civil Engineers (in accordance with census returns). Of the 20,000 of these registered in the roster, 32.8% are under the military figure, 38 years. The median age of the 20,000 is surprisingly high, 45 years. (As a matter of interest, comparison shows that 78% of the Aeronautical Engineers are under 38 years, and the median age for their group is 29.9.)

Conclusions: From the above specific, and other fragmentary, information the undersigned members of your Committee have reached the conclusions:

a. That both general and engineering employment on war construction passed the peak about August 1942.

b. That while general employment on such construction has been forecast as dropping to 50% of the peak by June 1943, the personnel comprising engineering organizations has dropped much more rapidly, and had already decreased to 50% of the peak by December 1, 1942.

c. That by April 1943 a very large part of our membership hitherto employed in war construction will either be unemployed or will have to be absorbed into other lines of work.

Recommendations: The undersigned members of your Committee earnestly recommend that an active program be undertaken to explore all prospective fields of employment, among which the following appear to be the most promising:

a. Transfer from War Construction to War Industry and Operation.

b. Transfer to the Armed Forces and to Construction Regiments, "Seabees," or other technical units of Army or Navy.

c. Post-war planning of engineering projects—a program still to be developed.

ALONZO J. HAMMOND
JOHN P. HOGAN
F. H. FOWLER, *Chairman*

Sewerage Section Proposed for Bureau of Governmental Requirements

FEAR has been expressed that shortages of materials and supplies due to war demands may be permitted to act to the detriment of essential sanitary engineering work. Evidences of this possibility are said to be already quite apparent. Alarmed at this idea, the Sanitary Engineering Division of the Society reported its misgivings to the Board at its January 21 meeting. The Board, in turn, adopted the following resolution, which has been forwarded to the President of the United States; to Donald M. Nelson, Chairman of the War Production Board; and to the Hon. Maury Maverick, Director of the Governmental Division, War Production Board:

> WHEREAS, the continued and satisfactory operation of public sewerage systems and sewage treatment works has been recognized as being essential to the successful prosecution of the war effort, and
>
> WHEREAS, the public health and welfare of a civilian and military population of more than 75,000,000 depend in large measure upon the effectiveness of the operation of such public sewerage systems and treatment works, and
>
> WHEREAS, it is necessary that adequate supplies be made available to maintain and operate successfully these necessary works, and
>
> WHEREAS, although it has been possible up to this time to obtain reasonable quantities of the necessary materials and supplies, it is feared that a critical situation may develop unless the sewage works field is given proper representation in the organization of the War Production Board,
>
> *Now, therefore, be it resolved* by the Board of Direction of the American Society of Civil Engineers that consideration be given by the War Production Board to the prompt and effective establishment of a Sewerage Section in the Bureau of Governmental Requirements, or some other branch of the War Production Board and that the staff of such Sewerage Section be composed of persons experienced in this field and fully familiar with its needs and requirements.

Delegates Attending the Midwestern Conference of Student Chapters

Midwestern Regional Conference of Student Chapters Held

The engineer in the war effort was the principal subject of discussion at the Second Annual Midwestern Regional Conference of Student Chapters, which was held at the University of Illinois on November 13 and 14. Despite restrictions in travel, there was an attendance of 118, with visiting delegates present from the Chapters at Iowa State College, Illinois Institute of Technology, Northwestern University, Purdue University, Rose Polytechnic Institute, the University of Washington, and the State University of Iowa.

The conference opened with an address of welcome by M. L. Enger, dean of the engineering college at the University of Illinois. He was followed by H. H. Jordan, associate dean of engineering, who discussed the aims of the conference, and Prof. W. C. Huntington, whose subject was "The Chapter and the Department." At the technical session that afternoon "Structural Engineering in Defense" was the topic of discussion. First on the program was J. F. Seiler, of the American Wood Preservers' Association, who gave an illustrated lecture on timber construction, emphasizing the importance of timber as a result of the priorities on metal and pointing out that the Armed Services are using composite construction to preserve metal. The other participant in the symposium was W. M. Wilson, research professor of structural engineering at the University of Illinois, who discussed the results of his research on the fatigue strength of riveted and welded structural members.

"Sanitary Engineering in Defense" was the subject of discussion at the Saturday morning session, which featured addresses by William Wisely and C. W. Klassen. Mr. Wisely, who is executive secretary of the Federation of Sewage Works Association, stressed the fact that sanitary engineering is a profession that conserves—not destroys—natural resources. The latter discussed the present shortage of sanitary engineers, citing the importance of the profession to the war effort. Mr. Klassen is chief engineer of the Illinois Public Health Department. The Saturday afternoon program consisted of a talk on airports by Dean Enger, and one on "The Effect of the War on Highways" by Mr. Fullenwider, of the Illinois State Highway Department. According to Dean Enger, the war has accelerated the development of air transportation to such an extent that the post-war era will see a great change in the transportation of passengers and freight. Mr. Fullenwider told the assemblage that the only roads being built in the state at the present time are the necessary trunk lines for military transportation. However, a great deal of maintenance work is being done to preserve the existing system until after the war. Because of the problem of priorities, recent specifications for highway bridges have called for the use of timbers with steel connectors instead of all-steel construction.

Social activities included a banquet on Friday night, with an after-dinner speech by James J. Doland, professor of civil engineering at the University of Illinois. Professor Doland spoke on construction difficulties in the Trinidad Defense Area, illustrating his talk by motion pictures in technicolor which he had taken himself. On Saturday night the delegates danced with "dates" secured by the social committee of the University of Illinois Chapter.

The executive committee of the conference announces that the convention was highly successful in its aim of directing the students' minds toward the war effort, and is of the opinion that such conferences should continue despite the general curtailing of all activities not directly contributing to the war effort. The conference was directed by I. Sterling Snyder, secretary-treasurer of the conference and president of the University of Illinois Chapter.

Metropolitan Student Conference

Representatives of 21 Student Chapters met at Society Headquarters on January 20, during the Annual Meeting of the Society, to compare the objectives of their Chapters and to study the effect of the war on engineering training; 168 representatives attended.

The group was addressed by E. M. Hastings, Vice-President of the Society and former chairman of the Committee on Student Chapters. Mr. Hastings clearly defined the challenge to engineering students today and assured the delegates that he was confident that they would accept the challenge and render service where it is needed. Past-President Black then discussed the effect of the war on engineering education. His analysis of contract education, which has spread through engineering colleges as a part of the War Department's training program, was sharply drawn. Under this program complete and inflexible courses of instruction are prescribed in the contract between the college and the War Department. Mr. Black stressed the importance of maintaining general engineering curricula so that men would be available to operate the planned peace to follow the war.

Professional license laws of many states were discussed by E. T. Larson, executive secretary of the National Society of Professional Engineers. The bargaining agencies that have been organized by the professional societies of several states were also explained.

Technical papers were presented by Verne Ketchum, of Timber Structures, Inc., and Prof. William A. Rose, of New York University. Mr. Ketchum, with the assistance of slides, demonstrated the effectiveness of prefabricated timber structures. Camouflage of industrial structures was Professor Rose's subject.

"Specialists' Pool" in Officers Reserve Corps

MEN, AGED 35 to 55, highly skilled, with good basic education and broad administrative or executive experience in several professional fields, including that of civil engineering, are wanted by the Military Government Division of the Provost Marshal General's Office, according to a memorandum issuing from that office. The Society has been asked to receive at headquarters indications of interest accompanied by a summary of professional, educational, technical, and practical experience. Information thus received will be forwarded promptly to the appropriate officer. Formal application blanks will be issued to inquirers from the Provost Marshal General's Office at a later date.

The memo, received just in time for insertion in this issue of CIVIL ENGINEERING, explains that a "Specialists' Pool" is being created. The members of this will be appointed in the Officers Reserve Corps, ultimately to be called to active duty in the military government of hostile areas occupied by American Armed Forces, when their services will be required.

To be eligible for a commission, applicants must have had a good basic education and broad administrative or executive experience in government with a state, county, city, or federal department, or as experts in public works, public health, sanitation, public safety, education, communications, public relations, public welfare, finance, or economics. Importance is attached to demonstrated administrative and executive ability, and to a knowledge of foreign countries and foreign languages.

It is anticipated that all such reserve officers will be called to active duty at Government expense for a period not exceeding four months for training, consisting of basic indoctrination and principles of military government. A very small number of those commissioned may be selected to attend the School of Military Government that is located at the University of Virginia, Charlottesville, Va.

Qualifications are defined as ability to deal effectively with important government and military officials; to get along well with persons of all types and strata of society; to handle difficult situations and problems; to express one's self forcefully and clearly; to be possessed of tact, diplomacy, understanding of social behavior and attitudes, imagination, and adaptability. Graduation from a recognized professional school will be waived only in exceptional cases. All candidates must have had at least five years of experience in an important administrative position involving broad executive experience.

Civil engineers experienced in public works and utilities, in public health, sanitation, communications, or in government and general administration are described as those who have been, or are, heads or principal officers of a public works or engineering organization, preferably public; a public health department or subdivision; or a public agency such as a department in a large city, in a state or in the federal government. Information regarding physical examinations, rank, pay, etc., has not yet been announced. Evidence of interest accompanied by summary of personal qualifications may be sent to the American Society of Civil Engineers, 33 West 39th St., New York City.

Board Adopts Resolution Re Problems in Engineering Education

ENGINEERS and educators alike have been concerned with developments in the colleges as affected by war conditions. This matter was discussed at length by the Board of Direction at its meeting on January 18, and as a result it adopted a series of resolutions under two headings: "A—Emergency Conditions in Engineering Education," and "B—Long-Range Problems and Objectives of Engineering Education." The wording of these resolutions was as follows:

BE IT RESOLVED by the Board of Direction of the American Society of Civil Engineers:

A. (1) That this Board hereby affirms its conviction that the maintenance of basic engineering education, as distinguished from engineering training for immediate and specific objectives, at a high level of efficiency is necessary both as an instrumentality for prosecuting the war and for post-war reconstruction and rehabilitation.

(2) That this Board recommends to the governmental agencies concerned that provision be made for enrolling and retaining in college a sufficient number of engineering students of superior qualifications, under such conditions as will permit them to complete substantially the time-proved engineering curricula, to meet the war and post-war needs for recruitment of the engineering profession.

(3) That this Board recommends to the governmental agencies concerned that the control in the colleges of the educational and training procedures by which the stated objectives of the armed services for engineering personnel are to be achieved be retained in the administrative and teaching staffs of the said engineering colleges.

(4) That this Board oppose as improper current attempts to convert liberal arts and non-scientific and non-technical curricula into so-called engineering courses.

B. (1) That this Board affirms its conviction that active participation in defining and promoting the basic educational standards of the profession of civil engineering is a necessary and proper function of the Society, and that such participation is hereby adopted as a policy of the Society.

(2) That this Board approves in principle the making of a fact-finding study of civil engineering education in the United States, in cooperation with the Civil Engineering Division of the Society for the Promotion of Engineering Education, and that the Committee on Engineering Education is hereby authorized and directed to confer with the said Civil Engineering Division of the Society for the Promotion of Engineering Education for the purpose of making preliminary plans for such a survey.

(3) That when and if the study proposed in (2) is made, there follow a formulation of acceptable standards of personnel, equipment, resources, and curricula to meet the basic educational needs of the profession of civil engineering.

(4) That when and if the steps proposed in (2) and (3) are completed, the Society prepare and publish its recommended standards of professional education and achievement requisite for qualification for admission to the practice of civil engineering as a profession.

The resolutions under series "A" have been forwarded to the President, to Secretaries Knox and Stimson, and to the Honorable Paul V. McNutt, head of the War Manpower Commission.

Members Under Arms Profit by Special Society Privileges

Many younger Society members in the armed services are now entitled to special considerations in the matter of dues. For those who may have missed the previous announcements, a repetition of the action of the Board of Direction at its October meeting is given as follows:

> "Cancellation of 1943 dues is hereby extended automatically to all those members of the Society in the armed services of the United States who are Selectees; and, upon request for such cancellation, to those commissioned officers receiving base pay of $2,400 or less. Those who receive this exemption will continue to be listed as members of the Society and have prior unpaid dues canceled; and those who are Corporate Members shall retain their voting rights. However, no publications except CIVIL ENGINEERING are to be forwarded to those thus exempted."

This policy was further implemented by a subsequent provision covering two particular cases: (A) members entering the service with dues paid in advance; (B) members in armed services who are unaware of the provisions for cancellation of dues. Members in these two categories upon request may secure return of dues computed on a prorated basis with respect to the period of eligibility.

Activities of Technical Divisions in 1942

At the January meeting of the Board of Direction, its Committee on Technical Activities reported for the year ending December 31, 1942. The report was submitted by Vice-President Charles B. Burdick as chairman of the Committee. Because some of the details given in this report are of general interest to the membership, excerpts have been culled as follows:

IN 1941, the work of the Technical Divisions was necessarily curtailed owing to the strenuous preparedness program in anticipation of war, which required the full time of a large number of Society members. Since the declaration of war in December 1941, the Division activities reflect a further curtailment in which programs were devoted almost entirely to matters useful in the conduct of the war. This reduced activity is clearly shown by the following statistics:

		1940	1941	1942
(*a*)	Total no. Tech. Divisions	12	12	12
(*b*)	Total membership Tech. Divisions	17,862	19,127	20,476
(*c*)	Total no. Exec. Comm. meetings	14	16	12
(*d*)	Total no. Div. sessions	37	36	30
(*e*)	Total attendance Div. sessions	3,830	2,813	2,580
(*f*)	Ave. attendance per session	90	78	67
(*g*)	Total no. committees	76	91	83
(*h*)	Total no. comm. reports	19	34	21
(*i*)	Total no. papers by Div. members	88	112	88
(*j*)	Annual allotment to Divisions	11,550	13,050	11,500
(*k*)	Annual expenditure of Divisions	8,440	7,010	6,688
(*l*)	Ratio of expenditures to allotments, %	73.2	53	58
(*m*)	Society membership (Dec. 31)	16,662	17,400	18,368
(*n*)	Ratio Div. membership to Soc. membership, %	107.2	109.8	111.5
(*o*)	Ratio attendance Div. meetings to Soc. membership, %	23	16	14.1

Comparing the statistics as between the years 1941 and 1942, it is noted that although the total enrolment in the Divisions increased 3.5% in 1942, the activities of the Divisions were reduced as follows:

Executive Committee meetings	25%
Total number of Division sessions	17%
Total attendance at Division sessions	8%
The average attendance per Division session increased from 78 in 1941 to 86 in 1942	
Total number of committees	9%
Total number of committee reports	38%
Total number of papers by Division members	21%

This Society has had a steady growth for 90 years. Its greatest value to the engineering profession during this long period has probably been its technical papers and discussions, which have made or have marked the advances in civil engineering. It is one of the misfortunes of war that this benefit must be curtailed until the war is won. The occupation of so large a part of the membership in the fighting force and its support must limit the technical programs to war activities.

In Pursuit of a Military Commission

A LETTER recently received at Headquarters details the experiences of an engineer offering his services to the Army. No circumstantial facts are known, other than those given in the following. Names of the author and of the locality are omitted since they have no bearing.

"*Secretary, A.S.C.E.*
New York, N.Y.

Subject: Shortage of Sanitary Engineers

"*Dear Sir:*

"In October last with your help, I became interested in a commission in the Army. The history of my case may be typical and of interest for this reason; briefly the events are as follows:

"On October 27, 1942, I left application for commission with the . . . in the Chamber of Commerce Building at *X*. On November 4, 1942, I was requested to report for interview in *Y* [about 125 miles from *X*.—Ed.]. Kept appointment as requested on November 10.

"Spent November 13, 14, 15 filling out Army forms and collecting references. The total length of forms finally submitted was 23.83 ft, believe it or not. These forms, about eight yards of 'em, were left in *X* on November 16.

"About November 20 I received form letter OPB3 without date, stating that 'your particular training and experience do not qualify you for consideration to fill any existing vacancy.'

"Now two things are commendable about the affair—first, the speed with which the Army processed the application, and second, the completeness of the information requested. The one thing that I deplore about the whole thing is that there is supposed to be a shortage of sanitary engineers for the Army and my application is now ignored. Since 1939, I have done little else but sanitary engineering and am at present employed as consultant for a Government agency on one of their sewage plants, and also designing sewage pump houses and disposal plants for the same agency. My age is 37."

January 25, 1943 (Signed)

Report of the Committee on Floods of the Hydraulics Division

ONE OF THE active committees in the Hydraulics Division is the Committee on Floods. Although handicapped by war conditions, the committee is continuing its work by correspondence. Some of the important questions at issue are summarized by Chairman Gerard H. Matthes in his annual report of the committee, as follows:

"The flood problem today, viewed from an engineering standpoint, is as complex as ever and demands consideration from at least three angles:

"1. A false sense of security appears to have been engendered in the public by the many flood protection works built, as well as projects not yet completed. There is a tendency for continued crowding in on flood plains by industries and individuals. Unless drastic zoning laws are passed, it is feared that there will be no great reduction in the amount of flood damage that will be witnessed in years to come.

"2. The time is ripe for the members of the Joint Committee to interest themselves in the solution of the various problems that will arise in the operation of flood protection works now completed, and those still under contemplation. This concerns more especially storage and release of flood waters at reservoirs. In small watersheds equipped with few reservoirs, operation for the benefit of local interests is a relatively simple problem. However, the difficulties that result from independent reservoir operation on many small watersheds and the cumulative effect thereof on the main stream to which these small watersheds may be tributary, looms today as an important problem confronting the profession.

"3. Consideration should be given to the advisability of recommending the removal from flood zones of residential districts, schools, hospitals, penitentiaries, railroad stations, and other public buildings; also the prevention of creating new flood hazards, in order that future demands for flood protection works may be effectively reduced. The annual costs of maintenance and operation of flood protection works now completed and those authorized to be built will saddle posterity with a huge as well as permanent burden. The justification of continuing to add to this burden, which is now placed on the public at large, demands consideration."

Preliminary Report on Soil Bearing Tests

AT A SESSION of the Soil Mechanics and Foundations Division held on January 21 in connection with the Society's Annual Meeting in New York, a preliminary report was presented on testing methods for the prediction of soil bearing values. This report, rendered by P. C. Rutledge, chairman of the Division's Committee on Sampling and Testing, covers work done by the Committee during 1942. The report includes a survey of existing soil tests, application of these tests to the prediction of bearing values, a study of theoretical analyses, and a proposed research program for the Committee.

News of Local Sections

Scheduled Meetings

CENTRAL OHIO SECTION—Luncheon meeting at the Fort Hayes Hotel on March 18, at 12 m.

CINCINNATI SECTION—Annual meeting at the Student Union, University of Cincinnati, on March 15, at 6:30 p.m.

CLEVELAND SECTION—Luncheon meeting at the Guildhall on March 8, at 12:15 p.m.

COLORADO SECTION—Dinner meeting at the University Club on March 8, at 6:30 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers' Club on March 15, at 12:15 p.m.

ILLINOIS SECTION—Dinner meeting in the Western Society of Engineers' Club Rooms on March 29, at 7 p.m. (Dinner will be held at the Old Town Room, Sherman Hotel, preceding the meeting at Western Society headquarters, 205 W. Wacker Drive.)

LOS ANGELES SECTION—Dinner meeting at the University Club on March 10, at 6:30 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building on March 17, at 8 p.m.; meeting of the Junior Branch in the Engineering Societies Building on March 10 and March 24, at 7:40 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on March 4, at 7 p.m.

MICHIGAN SECTION—Dinner meeting in the Rackham Building, Detroit, on March 19, at 6:30 p.m.

MID-SOUTH SECTION—All-day meeting in the Arkansas State Highway Building, Little Rock, Ark., on March 26, at 9 a.m.

NORTHEASTERN SECTION—Dinner meeting at the Engineers' Club on March 22, at 6 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Coffman Union, University of Minnesota, on March 1, at 6:30 p.m.

PHILADELPHIA SECTION—Meeting at the Engineers' Club on March 9, at 7:30 p.m. (Usual dinner at 6 p.m.)

SACRAMENTO SECTION—Regular Tuesday luncheon meetings.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on March 22, at 12:15 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section at the Tennessean Restaurant on March 9, at 6 p.m.; dinner meeting of the Knoxville Sub-Section at the S. & W. Cafeteria on March 9, at 5:45 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Y.M.C.A. Club on March 1, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on March 8, at 12:15 p.m.

TRI-CITY SECTION—Joint societies meeting, sponsored by War Production Board at the Blackhawk Hotel on March 4, at 6:30 p.m.

Recent Activities

BUFFALO SECTION

On January 11 the Buffalo Section assisted the War Production Board Clinic, which attracted a large attendance. At the regular meeting of the Section, which was held on the 26th, certificates of life membership were presented to several members of the Section. Two of these—Robert L. Allen and Lynn L. Davis—reminisced very interestingly concerning their engineering experiences. Mr. Davis is a veteran employee of the U.S. Engineer Office at Buffalo, having been in the district office there since 1896. At the conclusion of the meeting J. W. Cowper, Director of the Society, reported on the Board meeting held in New York in January.

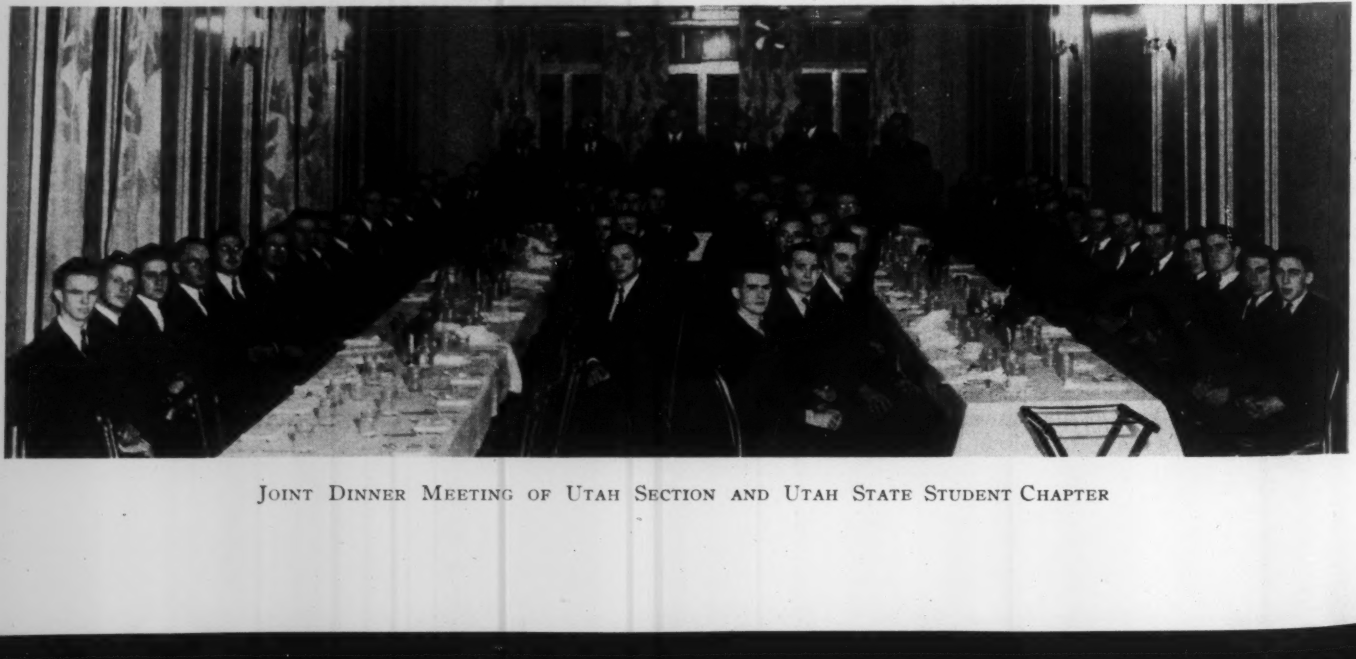
CLEVELAND SECTION

The December meeting of the Section took the form of a joint session with the Student Chapters at the Case School of Applied Science and Akron University. Travel restrictions kept the Ohio Northern University Chapter from attending. The guests were welcomed by Al Barnes, president of the Case Student Chapter, who called upon the Case seniors to present their theses in the annual competition for Section prizes. The talks covered a wide range of subjects, each of the speakers describing the problems encountered in bringing his thesis to a successful conclusion. Professor Barnes, of the Case School, then explained that since all the graduates of the three schools in the Section are entering some branch of the Armed Services and since Society dues for those below the rank of captain are waived, the Section will give awards other than those of Junior membership in the Society. As yet the type of award has not been worked out. The winners are James Sweitzer, of Ohio Northern; Richard Panek, of the Case School; and Ray Seece, of Akron University. The meeting concluded with a visit to the various laboratories where the thesis projects are in operation.

At the January meeting the following Section officers were elected for the coming year: G. Brooks Earnest, president; Mark Swisher, vice-president; and Arthur H. Stark, secretary-treasurer. The speaker of the evening was William A. Stinchcomb, executive director of the Cuyahoga County Council for Civilian Defense, whose subject was "Cleveland's War Picture."

UTAH SECTION

A joint dinner meeting of the Section and the Student Chapter at Utah State Agricultural College was held in Logan on January 22. All arrangements for the banquet and program were made by the Student Chapter. During dinner there was a program of music and entertainment, Eugene Henderson acting as toastmaster. Later G. D. Clyde, dean of the engineering school at the Utah State Agricultural College, spoke on the subject, "Our Engineering School and the War Effort," explaining the purpose of the "Division of Industries and Trades" at the college. Dean Clyde emphasized the importance of the engineer in this war of movement, machines, and technicians.



JOINT DINNER MEETING OF UTAH SECTION AND UTAH STATE STUDENT CHAPTER

Colorado Section

Speakers at the January meeting of the Section were D. E. Carberry and F. T. Ebersole, lieutenants, Civil Engineering Corps, U.S. Naval Reserve. Both discussed the "Sea Bees," emphasizing the need of this branch of the service for men with construction experience. Motion pictures, entitled "Advanced Base Construction" and "Cannon on Wings," were then shown. The latter deals with the construction of the Bell Aircraft Corporation's "Airacobra," the plane mounting a 37-mm cannon in addition to the usual complement of 0.50-caliber machine guns. On February 8 Roy Nelson, of the Colorado State Planning Board, spoke on "Public Works Planning."

Dayton Section

The use of wood as a structural material was discussed by Prof. J. J. Chamberlain, of the structural engineering department of the University of Dayton, at the January meeting of the Section. Professor Chamberlain said that wood is being used extensively in place of the more critical materials and that timber connectors are very popular now.

Kansas City Section

At the first meeting of the new year John Coleman Long described the construction of a new munitions plant in the vicinity of Kansas City. Mr. Long is with the Turner Construction Company, of New York, which is in charge of the construction of this project. New officers, elected at this session, are Joseph W. Ivy, president; O. W. J. Anschuetz, first vice-president; S. J. Callahan, second vice-president; and Melvin P. Hatcher, secretary-treasurer.

Los Angeles Section

The technical program for the December meeting consisted of a talk by Harry E. Keller on "The Present Aluminum Situation." Mr. Keller, who is general superintendent of the Los Angeles plant of the Aluminum Company of America, outlined the great amounts of strategic materials and machinery required to produce aluminum. The electric power required for the Los Angeles plant alone, he said, is almost 70% of the balance of the electric power load of the whole city. Mr. Keller also brought out the fact that the government is allotting silver, which has been in storage, for use in electric conductors in these plants. After the emergency the silver will be stored again. Lt. Comdr. H. W. Browning, of the Office of the Director of Naval Office Procurement, also spoke, outlining briefly the need for civil engineers as commissioned officers in the Construction Battalions of the Navy.

At the January meeting Arthur H. Young, lecturer on industrial relations at the California Institute of Technology, discussed the current labor situation. It is his opinion that some legislation must be enacted to control social rights. President Black also addressed the gathering.

Maryland Section

"Recent Developments in Bridge Design and Aerodynamic Effects on Suspension Bridges" was the subject of discussion at the January meeting. Scheduled speakers on this program were J. A. Mullin and R. Boynton. The latter traced the development of suspension bridges by means of slides from the Brooklyn Bridge down to the recent Tacoma-Narrows structure and, with the aid of models, explained the part that aerodynamics play in suspension bridges and how these effects are overcome. The new President of the Society, Ezra B. Whitman, was also present and spoke briefly, stressing the part that engineers must play in post-war planning. Mr. Whitman mentioned some of the things that the Maryland State Roads Commission, of which he is chairman, is planning to do in this respect.

Metropolitan Section

The activities of the Portland Cement Association in the field of cement research were discussed by F. R. McMillan, director of research for the association, at the January meeting of the Section. According to Mr. McMillan, the association has under way a comprehensive, long-time investigation covering the influence of cement characteristics on the durability of concrete. Five different types of cement from 27 manufacturers are being used in the study, and tests on concrete piling are being made in the Cape Cod Ship Canal, off the Atlantic coast of Florida, off the Gulf coast, and in the Pacific off southern California. Test roads have also been constructed in Missouri, New York, and in the South.

On February 10 the Junior Branch of the Section heard Woodman Scantlebury, design engineer for the Duramold Division of the Fairchild Airplane and Engine Company, speak on "Procedure in the Design of an Airplane." Through the courtesy of the Bell Aircraft Corporation the motion picture, "Cannons on Wings," was also shown.

Michigan Section

The technical program at the January meeting of the Michigan Section—held in Detroit on the 15th—consisted of talks by J. G. Schaub and Julian Mead. Mr. Schaub, who was recently appointed deputy commissioner for the Michigan State Highway Department, gave an illustrated lecture on the access highways that have been completed at the Willow Run Bomber Plant. Mr. Mead discussed the new Davison Limited Highway. He is chief bridge designer of the Wayne County Road Commission. Lieutenant Colburn, of the U.S. Navy, was also present and spoke briefly, outlining the need for experienced engineers in the Navy.

Mid-Missouri Section

On January 13 members of the Mid-Missouri Section entertained President Black at their annual meeting. During the business meeting the following officers were elected to serve for 1943: S. M. Rudder, president; Ernest W. Carlton, first vice-president; Wayne S. Frame, second vice-president; and W. J. Schulten, secretary-treasurer. The dinner following the business meeting was attended by members of the Engineers' Club of Jefferson City, Student Chapter officers from the Chapters at Rolla and Columbia, and lady guests. One of the highlights of the evening was the presentation of a certificate of life membership to Carl L. Sadler. In making the presentation, President Black discussed the high standards of the Society and emphasized the necessity of backing up our fighting forces with all the means of labor and industry at our disposal.

North Carolina Section

The winter meeting of the North Carolina Section took place in Charlotte on December 29. Following a dinner and brief business discussion, the speaker of the evening—Lt. Comdr. F. H. McElvaine—was introduced. Commander McElvaine, who is officer-in-charge of a local shell-loading plant, discussed the engineer's role in fighting the war and influencing public policy in the right direction.

Philadelphia Section

Employer-employee relationships in the engineering field was the topic of discussion at the January meeting, the speaker being Howard F. Peckworth, assistant to the Secretary of the Society. Mr. Peckworth analyzed the investigations he has undertaken for the Society. In making these studies, he traveled 14,000 miles throughout the country and later, in order to act as conciliator or adviser in seven difficult situations, he traveled another 9,000 miles. An unusually lively and protracted discussion followed Mr. Peckworth's address. Charles H. Stevens, retiring Vice-President of the Society, was chairman of the meeting.

Rochester Section

At the annual meeting of the Section, which took place on January 7, Carl Cooman presented films of the model of the proposed Mt. Morris Dam. Preceding the showing of the pictures, Mr. Cooman discussed the hydraulic problems peculiar to the flow of water over dams and, as the showing of the film progressed, the problems that he had discussed were dramatically demonstrated by the action of the model. New Section officers, elected at that time, are R. C. Schwind, president; T. Leach, first vice-president; E. H. Walker, second vice-president; and V. E. Warney, secretary-treasurer.

On January 9 the Section and members of the Rochester Engineering Society made a tour of inspection of the Kodak Optical Works factory at the invitation of Maj. Ira D. S. Kelly, area-engineer for the Corps of Engineers of the U.S. Army. Since several of the members of the Section had an active part in the design and construction of the building, the trip proved of great interest.

Sacramento Section

As usual the first two meetings of the Sacramento Section in January were devoted to local affairs and the annual dinner dance.

At the other two meetings the speakers were D. L. Breckner, acting regional director of information for the U.S. Bureau of Reclamation, and Norman C. Raab, senior engineer for the bridge department of the California Division of Highways. The former gave a kodachrome summary of progress to date on the Central Valley Project, while Mr. Raab discussed the progress report of the committee investigating the failure of the Tacoma-Narrows Bridge.

ST. LOUIS SECTION

Problems of priorities were discussed at the January luncheon meeting of the Section. The principal speakers were L. E. Crandall, deputy regional director for the St. Louis region of the War Production Board, and R. C. Taylor, Jr., manager of the Local Priorities District Office. Mr. Crandall explained the evolution of the "Controlled Materials Plan" out of the old priorities system, while Mr. Taylor discussed the details of this new plan to allocate the critical steel, copper, and aluminum for each project out of a total national pool. This plan promises to be more flexible than the old system and to assure the completion of vital projects. A résumé of the Annual Meeting was given by Robert B. Brooks, Director of the Society.

SOUTH CAROLINA SECTION

The annual meeting of the Section, held jointly with a session of the South Carolina Society of Engineers, took place in Columbia on January 8. The list of speakers scheduled for the technical session included J. S. Williamson, chief highway commissioner for the South Carolina State Highway Department; L. S. Le Tellier, head of the department of engineering at The Citadel; R. L. Sumwalt, professor of civil engineering at the University of South Carolina; and Col. David W. Griffiths, district engineer for the Corps of Engineers at Charleston. During the joint luncheon President Monk presented a certificate of life membership to E. L. Clarke. Walter E. Rowe, another recipient, was unable to be present. At the business meeting Professor Le Tellier was elected president, and L. A. Emerson, vice-president (for two years). Albert E. Johnson was reelected secretary-treasurer for a two-year term.

TACOMA SECTION

Members of the Section met at the College of Puget Sound on January 16 for a social evening. Everyone present enjoyed the excellent dinner and entered heartily into the spirit of the community "song-fest," led by F. M. Veatch with Mrs. Betty Warner Allen as accompanist. Later Miss Martha Sandin presented a selection of Swedish folk songs. Music for dancing was provided until midnight and was so thoroughly enjoyed that some of the bridge tables in the lounge were deserted by members who decided to test their dancing after years of neglect. The new officers for the Section, introduced at this gathering, are Charles H. Williams, president; C. A. Strong, vice-president; and N. E. Olson, secretary-treasurer.

TENNESSEE VALLEY SECTION

On January 18 the Chattanooga Sub-Section held a joint meeting with local groups of the other Founder Societies. The speaker was S. R. G. Finley, manager of the Chattanooga Electric Power Board, whose subject was "Electric Utility Post-War Planning." There was a large turnout for the January meeting of the Knoxville Sub-Section, the speaker being G. H. Hickox, senior hydraulic engineer for the TVA. His talk, which was illustrated with motion pictures, was on the subject of "Models and Prototype Performance of Tennessee Valley Dams." The Asheville Sub-Section met with the Engineers' Club of Western North Carolina on January 18. The speaker was Morriss Russel, special service engineer for the Southern Bell Telephone Company, who discussed war communications. A sound motion picture, entitled "Defense in Dixie," was also shown.

Student Chapter Notes

MISSOURI SCHOOL OF MINES AND METALLURGY

The Chapter at the Missouri School of Mines and Metallurgy reports an active and interesting year. On one occasion the group heard H. A. Humphreys, research engineer on soil-cement construction for the Portland Cement Association, speak on soil-cement construction. Mr. Humphreys traced the development of roads of this type from their initial stage—the first soil-cement highway was built in South Carolina in 1935—to the present. The first road was built on an experimental basis and was not intended to be perfect. However, the results obtained were so gratifying that a study of this new type of road was instigated by the Portland Cement Association. There are now 2,460 miles of soil-cement highways in the country, and several large airports are equipped with soil-cement runways. Members of the Chapter also attended the January meeting of the Mid-Missouri Section, at which President Black was guest of honor. The accompanying photograph depicts a typical Student Chapter meeting.

TYPICAL STUDENT CHAPTER MEETING AT THE MISSOURI SCHOOL OF MINES

SYRACUSE UNIVERSITY

Recent meetings of the Syracuse University Student Chapter have been devoted to business discussion and the showing of films. Two of the movies especially enjoyed were entitled the "Development of the Railroad" and "An Excursion in Science." Both films were shown through the courtesy of the publicity department of the General Electric Company.

UNIVERSITY OF ALABAMA

Members of the University of Alabama Chapter recently enjoyed an inspection tour over some of the Alabama State Highway Department's roads. The principal project was the University Highway, a bituminous surfaced road under construction between Montgomery and Tuscaloosa. Features of special interest were pointed out and explained by S. J. Cumming, third division engineer for the Alabama State Highway Department.

ITEMS OF INTEREST

About Engineers and Engineering

Two Members of Society Receive Moles Award

At a dinner held in New York on February 3 two members of the Society—Rear Admiral Ben Moreell and Frank W. Barnes—received the Moles Award, given annually for outstanding achievement in the heavy construction field. The award went to Admiral Moreell, newly elected Honorary Member of the Society and chief of the Bureau of Yards and Docks, "in recognition of his capacity and forcefulness to conceive, design, and accomplish the construction of Naval works and for his contribution to the War."

Frank W. Barnes

Similarly, Mr. Barnes was honored "in recognition of his enterprise, courage, and resourcefulness, notably in the field of foundations, bridges, tunnels, docks, and piers and for his contribution to the National Defense." At present he is in charge of construction of an off-shore base and projects in New England for the combined firm of George A. Fuller Company and the Merritt-Chapman and Scott Corporation. A photograph of Mr. Barnes is shown here; one of Admiral Moreell appeared in the January issue in connection with his election to honorary membership in the Society.

Army Seeks Suggestions

A recent communication from the Engineer School at Fort Belvoir, Va., calls attention to the fact that for over a year the School has been operating a suggestion system. All incoming mail is read eagerly, as any envelope may contain a revolutionary suggestion that will speed victory. To date eleven per cent of the suggestions received have been put into use, and more are wanted. In fact, an extensive poster and publicity campaign to promote suggestions has been started.

Engineer soldiers are authorized to send suggestions direct to the School without going through other military channels. Suggestions from civilians will also be welcomed. Every idea is judged by competent critics, and no useful idea is too small to report. Army officers believe that the suggestion system has an additional morale value, as each engineer soldier will realize that he can think and that his thinking may be helpful to the war effort.

Suggestions should be sent direct to the Engineer School at Fort Belvoir, Va.

N. G. Neare's Column

Conducted By

R. Robinson Rowe, M. Am. Soc. C.E.

"In assigning you the problem of Count de Myles' tires, I hoped to focus your attention first on the rotation of your own tires, so that, like the one hoss shay, all would wear out together."

"But, Noah, since you stated the problem in January, the policy on recapping has been changed. Would you advise us to rotate our tires so that we need 5 recaps all at once?"

"Why not, especially if that time may be in 1947, when rubber may not be scarce; it is scarce now. However, it's a gamble, with lots of wild cards in the deck, so I won't tell you how to play your own hands. Joe, you told me you found an easy way to solve count de Myles' rotation."

"Yes, Professor," said Joe Kerr, "and by straight arithmetic. I computed the number of miles each tire would carry the car if it could be on four wheels at once. Thus the right rear tire, worth 11,000 miles on the wheel where wear is 38% of the total, has a rubber potential of 4,180 miles for the whole car. For the set of five tires:

$$\begin{aligned} 0.38 \times 11{,}000 &= 4{,}180 \\ 0.29 \times 10{,}000 &= 2{,}900 \\ 0.19 \times 9{,}000 &= 1{,}710 \\ 0.14 \times 8{,}000 &= 1{,}120 \\ 0.14 \times 6{,}993 &= \underline{\quad 979.02} \\ \text{Total potential} \qquad & \ 10{,}889.02 \text{ miles} \end{aligned}$$

"You said it was easy, Professor, but I was surprised that it was that easy!"

"It wasn't," contradicted Cal Klater. "Joe figured the potential of each tire correctly, but the Count can't achieve such one-hoss-shay efficiency. If he drives only 10,889.02 miles, how can he wear out the first tire, which will last 11,000 miles in the worst spot?

"He should leave that tire where it is and figure the potential of the other four tires on 3 wheels. Since the wear percentages add up to 62, the set-up is:

$$\frac{29}{62} \times 10{,}000 + \frac{19}{62} \times 9{,}000 + \frac{14}{62} (8{,}000 + 6{,}993) = 10{,}821 \text{ miles}$$

So, if he has an A-card, the Count's rubber will last until August 1946."

"I agree with Cal," added Titus Wadhouse. "Run 5,358 miles as tired, then put the spare successively on the left rear, right front and left front wheels for 821, 1,821, and 2,821 miles, respectively. Then the Count would wear out 4 tires in 10,821 miles and have 179 miles of rubber left in the fifth.

"When I turned in my sixth tire last November, I estimated it was good for 8,000 miles. In return I received a Treasury check for 20 cents, which I framed as a masterpiece of understatement. Pro rata, Count de Myles can turn in his right rear tire and hope for a refund of $0.004475 from the rubberaucracy."

"Splendid," was the verdict of the Professor, "except that Titus' rotation plan may not be the cheapest. Many garages are charging 25 cents per wheel jacked plus 10 cents for handling the spare. At such rates, how should the Count plan his tire rotation?

The roster of Cal Klaters includes Ann Othernut (J. Charles Rathbun), Dean F. Peterson, Jr., Isidore Knobbe (Joseph D. Kambie), John C. Prior (who tried the problem on his senior class and recommended half of them for cum laudes), Tyro (Lynne J. Bevan), and Richard Jenney. Two of these were Joe Kerrs who second-guessed; the other Joes are incognito.]

Walter P. Murphy Wills 20 Million to Northwestern

Announcement has been made of the bequest of Walter P. Murphy to Northwestern University of an amount in excess of $20,000,000. There have been but a few previous gifts to institutes of higher education as significant as this. Mr. Murphy, a manufacturer of railway supplies, specified that the fund be used to develop, maintain, and operate the Technological Institute of Northwestern University. This institute was founded in 1939 with a gift of $6,735,000 from the Walter P. Murphy Foundation.

The massive building of the Institute, housing the departments of civil, chemical, mechanical, and electrical engineering, and the departments of physics and chemistry, was dedicated in June 1942. Built to accommodate a thousand engineering students, the Institute today has an enrolment of 750 full-time students and in addition is training 4,500 men and women to take their places in activities essential to the war effort.

Although Mr. Murphy expressed a desire that as much as possible of the principal be used for an endowment fund for the Institute, the trustees were empowered to spend portions of the principal and all of the annual income for buildings, equipment, professorships, scholarships, books, research, and such other purposes as they may think necessary to proper operation of the Institute.

Atom Smashing—Present and Future

Reprinted from the "Proceedings" of the 226th Meeting of the San Francisco Section December 15, 1942.

By GEORGE A. PETTITT

ASSISTANT TO THE PRESIDENT, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIF.

PRESENT-DAY research in nuclear physics may be regarded as the modern, scientific development of the dreams of the ancient alchemists who sought to transmute lead or quicksilver into gold. Greek philosophers postulated the existence of the atom, and as its name implies, considered it the smallest possible particle of matter, indivisible and unchangeable. The reality of the atom was scientifically proved by an English scientist, John Dalton, as early as 1810, but science did not begin to understand the nature of the atom until the 1890's, following the development of the Crookes tube, and the invention of the X-ray tube, which brought to light negatively charged particles of matter much smaller than atoms, named "electrons" by their identifier, the English scientist J. L. Thomson. Other particles smaller than an atom have since been discovered . . . .

Lord Rutherford and Niels Bohr, among others, were instrumental in developing a theoretical picture of what an atom might look like if it were only large enough to be seen. It is not a simple, solid particle, but a complex structure consisting of a tightly packed core or nucleus of protons and neutrons, around which electrons equal in number to the protons within the nucleus whirl at tremendous velocities, like moons around a planet. It was conceived that the only difference between kinds of matter, or elements, was in the number of protons and neutrons packed into the core of the atom. It was further conceived that transmutation of one kind of matter into another could be brought about by finding a bullet small enough and powerful enough to get through the whirling screen of electrons and penetrate the core or nucleus in such a manner that protons or neutrons would be knocked out of or added to it. The possibility of transmutation of one kind of matter into another was demonstrated by the discovery of radioactive matter, uranium by Becquerel and radium by the Curies. These elements are spontaneously transmuting themselves, radium, for example, giving off helium gas, among other things, and breaking down through a number of steps into a form of lead. Lord Rutherford proved experimentally that artificial transmutation was possible by using the particles of matter shot off by radium as bullets to bombard and actually transmute atoms of other substances. Radium, however, because of its rarity, costliness, and slow rate of disintegration, is not a practical source of bullets for atomic bombardment.

It is in this regard that the work of Dr. Ernest Orlando Lawrence, Nobel Prize Winner, 1939, and Professor of Physics at the University of California, takes on significance. The cyclotron which he has invented is in effect a subatomic machine gun which yields a barrage of bullets equivalent to what would be produced by 30 tons of radium if there were that much in existence and there was enough cash in the world to buy it. Difficulties of atom-hunting may be indicated by the fact that the nucleus of an average atom is so small that a thousand million billion of them might easily be packed on the point of a pin, and the electrons whirling around the nucleus have such a velocity that it would take an ordinary airplane propellor about four million years to make as many revolutions as these electrons make in one second. Dr. Lawrence meets this problem by using the nuclei of the smallest and lightest atoms, hydrogen gas, as his bullets, and by firing about 600,000,000,000,000 rounds per second at a velocity 50,000 times that of a rifle bullet.

The essence of his idea is to use a relatively small amount of electrical energy over and over again to gradually increase the velocity of the bullets. This is done by setting up a powerful magnetic field in which the potential bullets travel a spiral course outward from the center of an air-tight tank, passing twice between two electrically charged grids during each spiral. Each time the hydrogen gas bullets pass between the grids they receive a pull or kick of from 20,000 to 50,000 volts, and by the time they reach the circumference of the tank, traveling faster and faster, they may have an accumulated energy equal to a single drop through a potential of sixteen million volts. This stream of bullets passes right through a thin place in the metal wall of the tank and is directed at whatever target the physicists wish to bombard.

Accomplishments to date may be summarized as follows: (1) transmutation of any element known to man; (2) creation in the laboratory of a vast array of new, radioactive elements not known naturally on the face of the earth; (3) production of a strong beam of neutrons as a secondary phenomenon during the course of the bombardment of certain targets. The creation of artificial radioactive elements is opening up new horizons in science, on the one hand because of their possibilities as supplements or substitutes for radium in medical therapy, and on the other hand because they can be traced through the bodies of living animals and the structure of plants to throw new light on life processes. One important object, using artificial radioactive carbon, is to learn more about the mysterious process of photosynthesis, by which plants use the energy of the sun to create essential foodstuffs which make life on earth possible for higher animals. The neutron ray has great promise as a supplement to the X-ray and surgery in the treatment of cancer.

Looking forward to the future, Dr. Lawrence is now building a new cyclotron which will weigh some 4,900 tons, under a great dome on the Berkeley Hills. With it he hopes that new horizons even more spectacular than those already established will be revealed. Among other things he may have a try at the problem of releasing subatomic energy, the same kind of energy probably, that keeps the sun in operation century after century without apparent diminution of its mass.

Brief Notes

THE Midwest Power Conference, arranged by the Illinois Institute of Technology, will not be a war casualty. Decision to continue the conference was prompted by the fact that there has been considerable demand for the meeting as a stimulus for the production of power in the war effort. The conference, which has been endorsed as a vital meeting by government officials, will be held at the Palmer House in Chicago, April 9 and 10.

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IT IS announced that the exhibition of drawings on civil engineering subjects by Miss Lili Réthi will open at the Metropolitan Museum of Art, New York City, about March 6. The date originally set was February 20, as stated in the item on the exhibition in the February issue, page 119.

NEWS OF ENGINEERS

Personal Items About Society Members

CLOVIS J. HARKRIDER is now senior engineer for the Federal Public Housing Authority at Fort Worth, Tex. Until recently he was with the Defense Public Works Division of the Federal Works Agency at Fort Worth.

WILLIAM S. WALKER, lieutenant, D-V(S), U.S. Naval Reserve, who was disabled in line of duty at Pearl Harbor and honorably discharged, has become production engineer for the Dravo Corporation at Pittsburgh, Pa.

RICHARD SALMON, formerly airport engineer for Pan-American Grace Airways at Lima, Peru, is now construction superintendent on the erection of a Merchant Marine academy at Great Neck, N.Y.

FRANCIS J. WILSON, colonel, Corps of Engineers, U.S. Army, has been assigned to duty at Tulsa, Okla. Previously Colonel Wilson had his headquarters in Washington, D.C.

JOHN F. TRIBBLE has returned to his position as principal civil engineer for the Alabama State Highway Department, after completing an assignment as chief construction engineer for the firm of Goodwin and Van Keuren on the construction of an airport in Alabama.

HARRY EDMUND NEWELL, assistant chief engineer of the National Board of Fire Underwriters, New York City, has been awarded the James Turner Morehead Medal for his "leadership in developing standards for installation and operation of acetylene equipment and systems." Mr. Newell has been affiliated with the National Board of Fire Underwriters since 1909.

WILLIAM J. COX has been reappointed State Highway Commissioner of Connecticut for a four-year term, to begin July 1, 1943.

William D. Wiggins was recently promoted from the position of chief engineer for the Pennsylvania Railroad to that of vice-president in charge of engineering. His headquarters are in Philadelphia, Pa.

Lloyd Cedric Macabee, consulting engineer of Palo Alto, Calif., was recently appointed town engineer for Los Gatos, Calif.

Frank T. Darrow announces his retirement as chief engineer of the Burlington Lines after forty-five years of service with the railroad.

William W. Aultman has been granted a leave of absence as water purification engineer for the Metropolitan Water District of Southern California in order to accept a commission as lieutenant in the Construction Battalions of the U.S. Navy. He is temporarily assigned to Camp Allen, Norfolk, Va.

Richard Stephens, formerly an engineer for the International Boundary Commission at El Paso, Tex., has gone to Puerto Rico to serve on the engineering staff of J. L. Burkholder, who is directing naval construction work in the Caribbean area.

Hugh Jones was recently commissioned a captain in the Corps of Engineers, U.S. Army, and detailed to duty in the Salt Lake City (Utah) area.

W. G. Paton and **W. R. Engstrom** have been made vice-presidents of the Austin Company. Mr. Paton will also assume the posts of assistant secretary and assistant treasurer of the company. Mr. Paton was previously assistant to the general manager of the Cleveland office, while Mr. Engstrom was district manager for the company in Seattle.

Raymond P. Pennoyer is now a colonel of Infantry in the U.S. Army, assigned to the School of Military Government at the University of Virginia. Before he was called to active duty Colonel Pennoyer was structural engineer for the Carnegie Steel Company at Pittsburgh, Pa.

W. L. Picton has severed his connection with the C. N. Harrub Engineering Company at Nashville, Tenn., in order to go to Washington, D.C., where he will be with the War Production Board. Mr. Picton is president of the Nashville Section.

Paul E. Smelser, formerly junior engineer for the Operations Section of the U.S. Engineer Office at Mobile, Ala., has been commissioned a first lieutenant in the Corps of Engineers, U.S. Army, and is stationed in England.

Ralph B. Peck, until recently assistant subway engineer for the Chicago Department of Subways and Traction, has been appointed research assistant professor of soil mechanics at the University of Illinois.

Newton F. Hicks is now a member of the engineering department of the Douglas Aircraft Corporation at El Secundo, Calif. He was formerly assistant office engineer for the WPA at Lincoln, Nebr.

H. B. Bursley, previously managing associate for E. S. Draper Associates, of Charlotte, N.C., has accepted a position as engineer for the Asheboro Planning Commission, which was recently organized to plan the widening of the city streets.

John G. Schaub has been appointed deputy commissioner-business manager for the Michigan State Highway Department. Until lately he was assistant chief engineer.

Arthur J. Benline is on leave from his post as superintendent and acting deputy commissioner of the New York City Department of Housing and Buildings in order to accept a commission as lieutenant commander in the Civil Engineering Corps of the U.S. Naval Reserve. At present he is officer-in-charge of the 70th Naval Construction Battalion, which is in advance training at Davisville, R.I. Other members of the Society in the Battalion include Lieutenant (jg) **Joseph M. Roberts** and Ensign **Kurt M. Hueftle**.

C. G. Prahl, lieutenant, Civil Engineering Corps, U.S. Navy, has been serving since July 1942 as officer in charge of construction at the Marine Corps Air Station, Edenton, N.C. In a previous issue of Civil Engineering he was incorrectly listed as stationed at the Naval Construction Training Center, Norfolk, Va.

Charles F. Seifried has been appointed acting state highway superintendent of Wyoming. In addition to his new duties, he will continue to hold the post of chief engineer.

Wesley P. Bliffert is now a lieutenant (jg) in the Civil Engineering Corps of the U.S. Navy. Before being commissioned Lieutenant Bliffert was an engineer for the Tews Lime and Cement Company, of Milwaukee, Wis.

Richard de Charms has been promoted from the rank of lieutenant commander in the Civil Engineering Corps of the U.S. Naval Reserve to that of commander. Commander de Charms is now stationed at Cherry Point, N.C.

Michael C. Hinderlider is on temporary leave of absence from his office as state engineer of Colorado in order to accept an assignment in the office of the Missouri River division of the Corps of Engineers. He will be head of the Price Adjustment Section set up for the purpose of investigating contractors' profits in the defense construction program.

R. M. Beanfield, consulting engineer of Los Angeles, Calif., has been commissioned a major in the Corps of Engineers, U.S. Army, and assigned to active duty with the district engineer at Tucson, Ariz.

Leo F. Crowley and **Lewis C. Wilcoxen** are now lieutenants in the U.S. Naval Reserve, in training with the Construction Battalions of the Navy at Camp Allen, Norfolk, Va. Both were previously assistant civil engineers in the Detroit (Mich.) City Engineer's Office.

A. E. Niederhoff, senior structural engineer for the U.S. Army Engineers at Portland, Ore., has been assigned foreign duty with the Army Engineers. He will leave Portland in charge of a group of engineers and a geologist for engineering work in South America. He expects to be gone about three months.

M. H. R. Cogan was recently promoted from the position of designing engineering draftsman for the Shell Oil Company, Inc., to that of maintenance engineer of the chemical division. His headquarters are at Deer Park, Tex.

DECEASED

Thomas Clark Atwood (M. '11) president of Atwood and Weeks, Inc., of Durham, N.C., died on February 2, 1943. From 1907 to 1914 Mr. Atwood was with the New York Board of Water Supply, serving successively as assistant designing engineer and division engineer. He was then manager of the Yale Bowl at New Haven, and during the first World War was supervising engineer for the U.S. Navy at a destroyer plant in Massachusetts. From 1922 to 1924 he was a construction engineer at Chapel Hill, supervising a building program for the University of North Carolina. In the latter year he established his architectural firm, which later moved to Durham.

Howard Judson Cole (M. '99) retired civil engineer of Troy, N.Y., died on January 10, 1943, at the age of 78. Mr. Cole had maintained construction engineering practices in New York, Albany, and Ossining, N.Y. He helped plan New York's first subway and directed construction of the Essex County (New Jersey) park system. He had also been resident engineer in charge of sewer construction at Plattsburg, New Paltz, Pelham Manor, and Saranac Lake, N.Y.

Arthur James Griffin (M. '24) Chief Engineer of Highways and Sewers for the Borough of Brooklyn (N.Y.) died in that city on January 20, 1943. Mr. Griffin, who was 65, entered the service of the City of New York forty-seven years ago. During this entire period he was connected with the Highway Department. In his capacity as chief engineer, Mr. Griffin directed numerous extensions of the borough's sewer system.

Arthur Kraus (M. '26) principal assistant shop superintendent for the Navy Yard at Brooklyn, N.Y., died suddenly at his home in East Orange, N.J., on January 15, 1943. He was 55. Mr. Kraus had been at the Navy Yard since 1912—from 1923 on as assistant shop superintendent in charge of procurement. Earlier in his career he was with the New York Public Service Commission, and chief engineer for J. Riely Gordon, New York architect.

Robert Albertsen Marshall (M. '08) supervising engineer, United Engineers and Constructors, Inc., Philadelphia, Pa., died on January 14, 1943, following an accident. He was 73. From 1901 to 1920 Mr. Marshall was, successively, chief structural designer and structural engineer for Westinghouse, Church, Kerr and Company; from 1920 to 1926 supervising engineer for the Dwight P. Robinson Company, Inc.; from 1926 to 1928 supervising engineer for the Brooklyn Manhattan Transit Lines; and from 1928 to 1933 supervising engineer for United Engineers and Constructors, which he served on construction work in Brazil and the Argentine. He returned to United Engineers and Constructors in 1940.

Harry Thomas Paterson (M. '09) a civil engineer in the U.S. Engineer Office at Wilmington, N.C., died in that city recently. Mr. Paterson, who was 68, had spent most of his career with the U.S. Army Engineers. For the past ten years he had been stationed at Wilmington and, before that, was successively assistant engineer and associate engineer at Newbern, N.C.

Nathan Schein (M. '25) consulting engineer on construction for the Dravo Corporation, Pittsburgh, Pa., died at his home in that city on January 8, 1943. He was 58. Mr. Schein had been with the Pittsburgh Department of Public Works for thirty-five years—much of the time as division engineer. Long active in the Pittsburgh Section of the Society, he served as secretary for twenty years.

Arthur Clarence Shields (M. '27) president of the Pittsburgh and Shawmut Railroad at Kittaning, Pa., died on January 18, 1943. Mr. Shields had spent his entire career in railroad work, having been division engineer for the Chicago, Rock Island and Pacific Railroad, and (successively) engineer of maintenance of way, general manager, and vice-president of the Denver and Rio Grande Railroad. He became president and director of the Pittsburgh and Shawmut Railroad Company in 1940.

Col. C. E. Myers

C. E. Myers (M. '26) colonel, Corps of Engineers, U.S. Army, was killed recently in an automobile accident "in a western European area." On January 31 Colonel Myers would have been 55. From 1909 to 1911 he taught at his alma mater, Pennsylvania Military College; and from 1911 to 1921 he was with the Pennsylvania State Highway Department, serving continuously except for a year when he was furloughed to enter the military service. During the first World War, he was a captain and major in the U.S. Corps of Engineers. He was in the service of the City of Philadelphia from 1921 to 1932—successively as engineer of construction and deputy chief of the Bureau of Highways, and director of the Department of City Transit. From 1932 until the outbreak of the present war Colonel Myers was engaged in general consulting practice in Philadelphia. Before going overseas a few months ago, he constructed the Army encampment at Fort Belvoir, Va., and the reception center at New Cumberland, Pa. He was a former president of the Philadelphia Section, and Director of the Society from District 4 from 1936 to 1938.

Harry Tinker Poe (M. '39) president of the Poe Construction Company at Greenville, S.C., died on November 21, 1942, at the age of 61. Mr. Poe had been city engineer of Greenville and of Americus, Ga., and from 1910 to 1914 was chief engineer for the Buckeye Cotton Oil Mills. During the war he was field engineer on the construction of Camp Sevier, S.C., and from 1920 to 1937 president of the Poe Construction Company. From 1938 to 1940 he was principal engineer for the PWA on the Santee-Cooper Project. In the latter year he resumed his construction practice.

Nathaniel Atherton Richards (M. '31) president of Purdy and Henderson Associates, Inc., of New York, N.Y., died at his home in Maplewood, N.J., on January 19, 1943. Mr. Richards, who was 59, was an expert in the windbracing of skyscrapers. He joined the Purdy and Henderson Company in Boston in 1905, going to New York with the same organization several years later. He became chief engineer of the company in 1916, vice-president in 1920, and president in 1934.

Robert Lee Whitehead (Assoc. M. '33) resident engineer for the North Carolina State Highway and Public Works Commission at Enfield, N.C., died recently at Elkin, N.C. Mr. Whitehead, who was 47, had been with the North Carolina State Highway Commission since 1922—from 1924 on as resident engineer. Earlier he had been with Larson and Fox, of Perth Amboy, N.J., and from 1919 to 1921 was assistant superintendent of bridge construction for F. L. Grant, Inc., of Clarksburg, Va.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From January 10 to February 9, 1943, Inclusive

Additions to Membership

Agnew, John Park, Jr. (Jun. '42), 2d Lt., U. S. Army, 3116 Columbia Pike, Arlington, Va.

Allen, Austin Douglas (Jun. '43), Associate Civ. Engr., Utah-Pomeroy-Morrison Constr. Co. (Res., 392 North 7th, East), Provo, Utah.

Anderson, Albert Edwin (Jun. '42), Engr., North Am. Aviation, Inc., Inglewood (Res., 120 Thirty-Fifth St., Hermosa), Calif.

Baird, Merle Delton (Jun. '42), Ensign, CEC, U.S.N.R., 76th Battalion, Camp Bradford, Norfolk, Va.

Balala, Ben (Jun. '43), Asst. Bridge Engr., State Bridge Dept., Public Works Bldg., Sacramento, Calif.

Ballinger, Web Wilkins (Assoc. M. '42), 1st Lt., Corps of Engrs., U.S. Army, Office of Post Engr., Fort Ord, Calif.

Barker, Lawrence Spears, Jr. (Jun. '43), 2d Lt., U.S.M.C.R., 1906 Vine St., Chattanooga, Tenn.

Baughman, John Henry (Jun. '42), Junior Structural Engr., TVA, Moreland, Ky.

Beadle, Herbert J. (Assoc. M. '42), Lt., CEC, U.S.N.R., 2210 Nueces St., Austin, Tex.

Bengal, Vernon Charles (Jun. '42), With U.S. Army, 537 North Broadway, Blackfoot, Idaho.

Bennett, John Wray (Jun. '42), Lt., U.S. Army, Company Comdr., Engr. Training Company, Company C, 4th Battalion, Engr. Replacement Training Center, Fort Belvoir, Va.

Blanchard, James Edwin (Jun. '42), Junior Draftsman, Goodyear Aircraft Corp., Dept. 18, Plant C (Res., 275 The Brooklands), Akron, Ohio.

Blazek, Harry James (Assoc. M. '43), Engr. (Civ.), U.S. Engr. Office, Box 1070 (Res., 1167 Greenland Ave.), Nashville, Tenn.

Boston, George William (Jun. '42), Draftsman, U.S. Engrs., Paris, Tenn. (Res., 818 South 7th St., Mayfield, Ky.)

Boughan, Rolla Beryl (Jun. '42), Junior Engr., National Advisory Comm. Aeronautics, Langley Field (Res., 414 Marshall St., Hampton), Va.

Bowman, Charles Rudolph (Jun. '42), Junior Public Health Engr., State Board of Health, Capitol Bldg., Pierre, S.Dak.

Bradley, John Allen (Assoc. M. '43), Asst. Flood Control Engr., Orange County Flood Control Dist., Court House Annex (Res., 1426 South Garnsey St.), Santa Ana, Calif.

Braswell, Andrew Melvin, Jr. (Jun. '42) Aviation Cadet, Air Force, U.S. Army, 1070 Glendon Ave., Apt. 305, West Los Angeles, Calif.

Britton, John Claude (Jun. '42), With U.S.N., 407 West Atwood St., Galion, Ohio.

Brockmeier, Glenn Charles (Jun. '42), Corporal, 826th Engr. Battalion, U.S. Army, 5117 North Minnesota Ave., Portland, Ore.

Burroughs, Robert Bernard (Jun. '42), Lt., U.S. Army, Company B, 386th Engr. Battalion, Sanbornville, N.H.

Burton, Fredric Cady (Jun. '42), Engr., Dravo Corp., Neville Island, Pittsburgh, Pa.

Calderón, Héctor Miguel (Jun. '42), Head, Soil Mechanics Laboratory, Dept. of Communications and Public Works (Res., Ave. Revolucion 595, S. Pedro de los Pinos), Mexico, D.F., Mexico.

Canham, Robert Allen (Jun. '42), Engr., The M. W. Kellogg Co., Box 1150 (Res., 401 Fifth Ave.), Port Arthur, Tex.

Chewning, Charles Carpenter (Jun. '42), Lt., U.S. Army, Fort Riley, Kans.

Coffey, John James (Jun. '42), Civ. Engr., Gibbs & Hill, Inc., Pennsylvania Station, New